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FINAL FOURTH FIVE-YEAR REVIEW (PUBLIC DOCUMENT)

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Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

FINAL
FOURTH FIVE-YEAR REVIEW

HUNTERS POINT NAVAL SHIPYARD, SAN FRANCISCO, CA

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DCN: IEJV-4804-0000-0009

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HUNTERS POINT NAVAL SHIPYARD, SAN FRANCISCO, CA

July 2019

Prepared for:

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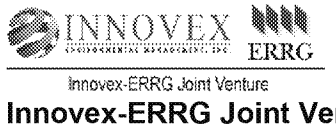

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Contract Number: N62473-17-C-4804
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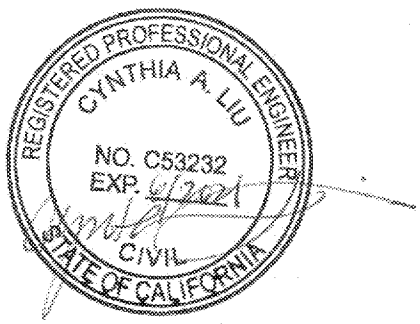
Final
Fourth Five-Year Review
Hunters Point Naval Shipyard
San Francisco, California

Submitted by:
Innovex-ERRG Joint Venture

Signature	July 31, 2019 Date
Cynthia Liu, P.E. Name	President and CEO, ERRG Title



Executive Summary

This report presents the fourth five-year review conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at Hunters Point Naval Shipyard (HPNS) in San Francisco, California. The review was conducted in accordance with the "Navy and Marine Corps Policy for Conducting CERCLA Statutory Five-Year Reviews" (Department of the Navy [Navy], 2011b) and the U.S. Environmental Protection Agency's (EPA) "Comprehensive Five-Year Review Guidance" (EPA, 2001), including supplemental documents (EPA, 2011, 2012a, and 2012b) and the "Five-Year Review Recommended Template, OLEM 9200.0-89" (EPA, 2016).

HPNS is a closed military base located in southeastern San Francisco on a peninsula that extends to the east into San Francisco Bay. HPNS currently consists of 846 acres: 403 acres on land and 443 acres under water in the San Francisco Bay. HPNS is currently divided into nine parcels and two independent installation restoration (IR) sites: Parcels B-1, B-2, C, D-1, E, E-2, F, G, and UC-3 and IR-07 and IR-18. HPNS formerly included Parcels A, D-2, UC-1, and UC-2, but they were transferred out of federal ownership to the City and County of San Francisco's Office of Community Investment and Infrastructure, which is the successor agency to the San Francisco Redevelopment Agency.

Records of Decision (RODs) have been completed for all parcels except Parcel F. This fourth five-year review focuses on the parcels (specifically, B-1, B-2, C, D-1, D-2, E, E-2, G, UC-1, UC-2, and UC-3) where remedial actions (RAs) have been completed or are under way, including parcels that transferred out of Navy ownership within the last 5 years, and includes summary status information for all parcels, except former Parcel A and Parcel F. Parcel A is not discussed in this report because the parcel required no action under CERCLA. Parcel A was removed from the National Priorities List in 1999 and transferred out of Navy ownership in 2004. Concerns over the safety of Parcel A are being addressed by the California Department of Public Health. Parcel F is not discussed in this report because the ROD has not been completed.

This five-year review included interviews of personnel and community members, review of relevant documents and data, site inspections, and development of this Five-Year Review Report. The purpose of this review was to evaluate the performance of remedies that have been implemented at HPNS to verify they remain protective of human health and the environment. This Five-Year Review Report also states whether each remedy is or will be protective, identifies any deficiencies, and recommends actions for improvement if the remedy has not performed, or is not performing, as designed.

This statutory five-year review is required by, and conducted according to, CERCLA Section (§) 121(c) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) at Title 40 Code of Federal Regulations § 300.430(f)(4)(ii) because the selected remedies will not reduce contaminant concentrations to

levels allowing for unlimited use and unrestricted exposure, and because RODs were signed after October 17, 1986. The trigger date for this five-year review is the date of the third five-year review: November 8, 2013 (TriEco-Tetra Tech Sustainable Resources Joint Venture, 2013b).

The following five-year review summary form provides additional information on the review process.

SITE IDENTIFICATION		
Site Name: Hunters Point Naval Shipyard		
EPA ID: CA1170090087		
Region: 9	**State:** CA	**City/County:** San Francisco/San Francisco
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: Other Federal Agency ***[If "Other Federal Agency", enter Agency name]*:** Department of the Navy		
Author name (Federal or State Project Manager): Doug Bielskis		
Author affiliation: Innovex-ERRG Joint Venture		
Review period: 11/1/2013 - 11/30/2018		
Date of site inspection: 1/29/2018		
Type of review: Statutory		
Review number: 4		
Triggering action date: 11/8/2013		
Due date *(five years after triggering action date)*: 11/8/2018		

The review identified several issues, recommendations, and follow-up actions to ensure the long-term protectiveness of the completed remedies. Most notably, the Navy has determined that a significant portion of the radiological survey and remediation work completed to date was not reliable because of manipulation and/or falsification of data by one of its radiological remediation contractors. It is currently not known if the remedial action objectives (RAOs) for radionuclides have been achieved in Parcels B-1, B-2, C, D-2, G, E, UC-1, UC-2, and UC-3. The Navy is currently in the process of implementing corrective actions to ensure the radiological remedies specified in the decision documents are implemented as intended. The radiological rework will successfully achieve the RAOs for radionuclides specified in the RODs. Additionally, the Navy included a recommendation to evaluate the radiological remediation goals using current EPA guidance to ensure the radiological remedies will be protective in the long-term, with human health risk falling within the risk range as described in the NCP.

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Abbreviations and Acronyms

Alliance	The Alliance Compliance Group Joint Venture
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
APTIM	APTIM Federal Services, LLC
ARARs	applicable or relevant and appropriate requirements
ARCADIS	ARCADIS U.S., Inc.
ARICs	areas requiring institutional controls
AST	aboveground storage tank
BCT	BRAC Cleanup Team
BGMP	Basewide Groundwater Monitoring Program
bgs	below ground surface
BRAC	Base Realignment and Closure
CalEPA	California Environmental Protection Agency
CDPH	California Department of Public Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CES	Construction Engineering Services, LLC
CIJV	Cabrera Insight Joint Venture
COCs	chemical of concern
COECs	chemicals of ecological concern
COPECs	chemicals of potential ecological concern
CRUP	Covenant to Restrict Use of Property
CVOCs	chlorinated volatile organic compounds
DTSC	Department of Toxic Substances Control
DTSC-SLs	DTSC-modified screening levels
EPA	U.S. Environmental Protection Agency
ERRG	Engineering/Remediation Resources Group, Inc.
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FS	feasibility study
FSC	federal screening criterion
HHRAs	human health risk assessments
HI	hazard index
HQ	hazard quotient
HPAL	Hunters Point ambient level
HPNS	Hunters Point Naval Shipyard

ICs	institutional controls
IR	Installation Restoration
ISB	in-situ bioremediation
IEJV	Innovex-ERRG Joint Venture
ISS	in-situ solidification/stabilization
ISTR	in-situ thermal remediation
ITSI	Innovative Technical Solutions, Inc.
JEM	Johnson and Ettinger model
JV	Joint Venture
KCH	CH2M HILL Kleinfelder, A Joint Venture
LLRW	low-level radioactive waste
LOQs	limits of quantitation
LTM	long-term monitoring
LUC	land use control
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCLs	maximum contaminant levels
MCP	Monitoring and Control Plan
MNA	monitored natural attenuation
msl	mean sea level
NAPL	nonaqueous-phase liquids
NAVSEA	Naval Sea Systems Command
Navy	Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ng/L	nanograms per liter
NMOCs	nonmethane organic compounds
NRDL	Naval Radiological Defense Laboratory
OCII	Office of Community Investment and Infrastructure
O&M	operation and maintenance
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFBS	perfluorobutane sulfonate
PFOS	perfluorooctane sulfonate
PQL	practical quantitation limit
PRC	PRC Environmental Management, Inc.
PRGs	preliminary remediation goals

RAs	remedial actions
RAOs	remedial action objectives
RACR	Remedial Action Completion Report
RAWP	Remedial Action Work Plan
RBC	risk-based concentration
RCPs	representative concentration pathways
RD	Remedial Design
RGs	remediation goals
RIs	remedial investigations
RODs	Records of Decision
RSL	Regional Screening Level
RU	Remedial Unit
SES	Sealaska Environmental Services, LLC
SFRA	San Francisco Redevelopment Agency
SGALs	soil gas action levels
Shaw	Shaw Environmental & Infrastructure, Inc.
SVE	soil vapor extraction
SVOCs	semivolatile organic compounds
SWRCB	State Water Resources Control Board
TBC	to be considered
TCE	trichloroethene
TCRA	time-critical removal action
TLs	trigger levels
TtEC	Tetra Tech EC, Inc.
TtEMI	Tetra Tech EM Inc.
TriEco-Tt	TriEco-Tetra Tech Sustainable Resources Joint Venture
Triple A	Triple A Machine Shop, Inc.
TPH	total petroleum hydrocarbons
UST	underground storage tank
VC	vinyl chloride
VISLs	Vapor Intrusion Screening Levels
VOCs	volatile organic compounds
Water Board	San Francisco Bay Regional Water Quality Control Board
ZVI	zero-valent iron
µg/L	micrograms per liter
§	Section

Section 1. Introduction

This report documents the results of the fourth five-year review conducted for Hunters Point Naval Shipyard (HPNS) in San Francisco, California. The purpose of the fourth five-year review is to provide an update on the status of remedial actions (RAs) and post-RA activities implemented since the third five-year review, evaluate whether these RAs and post-RA activities are protective of human health and the environment, and assess the progress toward meeting the recommendations made in the third five-year review. This Fourth Five-Year Review Report also identifies issues found during this fourth five-year review and recommendations to address them. The five-year review applies to all RAs selected pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section (§) 121(c) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA § 121(c) states:

> *"If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews."*

This requirement is further interpreted in the NCP [Title 40 Code of Federal Regulations § 300.430(f)(4)(ii)], which states:

> *"If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action."*

Consistent with Executive Order 12580, the Secretary of Defense is responsible for ensuring that five-year reviews are conducted at all qualifying U.S. Department of Defense cleanup sites. The Department of the Navy (Navy) is authorized to conduct the five-year review for HPNS in accordance with CERCLA § 121 and the NCP.

This fourth five-year review was conducted for all parcels at HPNS (except Parcels A and F), and summarizes the significant work conducted by the Navy in collaboration with the regulatory agencies, including the U.S. Environmental Protection Agency (EPA), the Department of Toxic Substances Control

(DTSC), and the San Francisco Bay Regional Water Quality Control Board (Water Board). This five-year review focuses on parcels (specifically, B-1, B-2, C, D-1, D-2, E, E-2, G, UC-1, UC-2, and UC-3) where RAs have been completed or are under way, including parcels that transferred out of Navy ownership within the last 5 years, and includes summary status information for all parcels, except former Parcel A. Parcel A is not discussed in this report because the parcel required no action under CERCLA. Parcel A was removed from the National Priorities List in 1999 and transferred out of Navy ownership in 2004. Concerns over the safety of Parcel A are being addressed by the California Department of Public Health. Parcel F is not discussed in this report because the ROD has not been completed.

This review is triggered by the date of the third five-year review: November 8, 2013 (TriEco-Tetra Tech Sustainable Resources Joint Venture [TriEco-Tt], 2013b). The review was conducted, by Navy personnel and their contractor representatives, from December 2017 through November 2018.

Five-year reviews are required for HPNS because (1) ongoing and completed RAs have left contaminants in place above concentrations that would allow for unlimited use and unrestricted exposure and (2) the Records of Decision (RODs) were signed on or after October 17, 1986 (the effective date of the Superfund Amendments and Reauthorization Act). This five-year review was conducted in accordance with the following guidance documents:

- "Navy/Marine Corps Policy for Conducting Comprehensive Environmental Response, Compensation, and Liability Act Statutory Five-Year Reviews" (Navy, 2011b)
- "Comprehensive Five-Year Review Guidance" (EPA, 2001)
- "Five-Year Review Recommended Template, OLEM 9200.0-89" (EPA, 2016)
- "Recommended Evaluation of Institutional Controls: Supplement to the 'Comprehensive Five-Year Review Guidance,' OSWER Directive 9355.7-18" (EPA, 2011)
- "Memorandum: Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews" (EPA, 2012a)
- "Assessing Protectiveness at Sites for Vapor Intrusion, Supplement to the 'Comprehensive Five-Year Review Guidance,' OSWER Directive 9200.2-84" (EPA, 2012b)

Following this introduction, this Fourth Five-Year Review Report is organized in the following sections:

- Section 2, Site Background, describes background information for HPNS, including location and physical characteristics, geography, topography, hydrostratigraphy, and land and resource use
- Section 3, Response Action Summary, describes the basis for taking action, response actions taken before the RODs, and the status of implementation of RAs in each parcel
- Section 4, Progress Since Last Five-Year Review, summarizes actions since the 2013 five-year review

- Section 5, Five-Year Review Process, describes the components of the five-year review process, including community notification, involvement, and site interviews; document and data review; and site inspections
- Section 6, Technical Assessment, presents the analysis of whether the remedies are functioning as intended; whether the standards and to be considered (TBC) criteria, toxicity data, risk assessment methodology, and exposure assumptions are still valid, as well as whether the remedy is progressing as expected; and whether any other information has come to light that could call into question the protectiveness of the remedies
- Section 7, Issues, Recommendations, and Other Findings, presents issues and provides recommended actions based on the technical assessment
- Section 8, Protectiveness Statements, lists the protectiveness statement for each parcel
- Section 9, Next Review, provides the schedule for the next five-year review

Figures and tables are presented after Section 9. Appendices containing supporting information are presented after the figures and tables. Appendix A contains the list of references cited in this report and the documents that were reviewed in support of this five-year review. Appendix B contains the regulatory agency interview and community member survey records, along with correspondence received from several community stakeholders following the public review of the draft Fourth Five-Year Review Report. Appendix C contains the checklists and photographic logs documenting the observations made during the site inspections. Appendix D contains figures detailing recent groundwater data at Parcels B-1, B-2, C, D-1, and G. Appendix E contains a supplemental risk evaluation related to volatile organic compound (VOC) vapors. Appendix F contains responses to regulatory agency comments on the Draft Fourth Five-Year Review Report.

Section 2. Site Background

This section provides background information on HPNS. General site conditions are discussed, including location and physical characteristics, geography, topography, hydrostratigraphy, and land and resource use. All background information summarized in this section is from the Third Five-Year Review Report (TriEco-Tt, 2013b), unless otherwise noted.

2.1. LOCATION AND PHYSICAL CHARACTERISTICS

HPNS is located in the City and County of San Francisco, California (Figure 1). HPNS encompasses 846 acres (403 acres on land and 443 acres under water in San Francisco Bay) in southeastern San Francisco on a peninsula that extends east into San Francisco Bay (Figure 1). HPNS is currently divided into nine parcels and two independent Installation Restoration (IR) sites: Parcels B-1, B-2, C, D-1, E, E-2, F, G, and UC-3 and IR-07 and IR-18 (Figure 2). HPNS formerly included Parcels A, D-2, UC-1, and UC-2, but they have been transferred out of federal ownership to the City and County of San Francisco's Office of Community Investment and Infrastructure (OCII), which is the successor agency to the San Francisco Redevelopment Agency (SFRA). The approximate area of each parcel and IR site is listed below.

Parcel or IR Site (Navy Property)	Approximate Area (acres)
B-1	27
B-2 (including IR-07 and IR-18)	27
C	74
D-1	49
E	126
E-2	47
F	443
G	40
UC-3	12
Former Parcel (Non-Navy Property)	**Approximate Area (acres)**
A	75
D-2	6.04
UC-1	4
UC-2	4

2.2. GEOGRAPHY

In 1992, the Navy divided HPNS into five contiguous parcels (Parcels A through E). In 1996, the Navy added a sixth parcel (Parcel F), which encompasses immediately adjacent areas of San Francisco Bay; Parcel F is referred to as the "offshore area." In 2004, the Navy divided Parcel E into two parcels (E and E-2) to facilitate closure of the Parcel E-2 landfill and its adjacent areas and transferred Parcel A to the OCII. In 2008, the Navy subdivided Parcel D into four separate parcels (D-1, D-2, G, and UC-1) and separated the western edge of Parcel C to create Parcel UC-2; these changes were made to expedite closure and transfer of the new parcels. In 2008, the Navy also separated the IR-07 and IR-18 (hereinafter referred to as "IR-07/18") from the rest of Parcel B to expedite the remedy completion and transfer of these sites. In 2012, the Navy separated the Crisp Road roadway and adjacent areas of Parcel E to create Parcel UC-3. The UC-series parcels encompass mostly roadways and were created to facilitate the overall transfer and development of HPNS. In 2013, following the issuance of the Third Five-Year Review Report, the Navy subdivided Parcel B, excluding IR-07/18, into two separate parcels (B-1 and B-2) to accommodate varying property transfer schedules for different portions of the original parcel (Engineering/Remediation Resources Group, Inc. [ERRG], 2017). In 2015, the Navy transferred Parcels D-2, UC-1, and UC-2 to the OCII.

At each HPNS parcel, contaminated sites were designated as IR sites based on information developed during previous investigations. IR sites were in most cases identified by a two-digit number (e.g., IR-02). Site characterization activities and sampling data were mostly planned and organized by IR site. Figure 2 shows the locations of the IR sites across HPNS.

2.3. TOPOGRAPHY

The topography of HPNS is characterized by a central hill (former Parcel A) and surrounding areas extending radially out to San Francisco Bay. At the current parcels, ground surface elevations range from about 30 to 60 feet above mean sea level (msl) near their landward edges and slope down to 0 feet above msl as they meet the bay. Large areas of HPNS are flat lowlands with elevations of about 10 to 15 feet above msl, where most of the base roads, buildings, and operating areas were built. The Navy created most of the dry land portion of HPNS in the 1940s by excavating the hills surrounding the shipyard and using the resulting spoils to expand the shoreline into San Francisco Bay. Some additional shoreline filling operations continued into the 1960s.

Most of the shoreline at HPNS is constructed seawalls or dry docks. The shorelines at all of IR-07 and portions of Parcels B-1 and B-2 are covered by shoreline protection materials consisting of engineered riprap (ERRG, 2012a and 2017; Innovex-ERRG Joint Venture [IEJV], 2018b). The shorelines at most of Parcel E and all of Parcel E-2 are either unimproved or partially to completely covered by shoreline protection materials consisting of irregularly placed concrete rubble and debris. Most upland areas are paved or covered by buildings, and the remaining unpaved areas support a ruderal habitat characterized by scattered to moderately dense growths of grasses and shrubs. Small wetland areas exist in intertidal areas

at Parcels E and E-2 (Navy, 2013e and 2012b, respectively). The Remedial Action Completion Reports (RACRs) for IR-07/18 and Parcels B-1, B-2, C, and G and the RODs for Parcels D-1, E, and E-2 (see Appendix A) further describe the current topography of these parcels.

Shoreline and offshore areas at HPNS are considered environmentally sensitive areas, and effects to wildlife in environmentally sensitive areas were considered during the remedy selection and design process. Specifically, the selected remedies at Parcels B, E, and E-2 involve varying degrees of excavation of contaminated sediment to protect human health and the environment that require minor filling of onsite wetlands, the loss of which would be mitigated by the Navy (on site at Parcel E-2). The Final Remedial Design (RD) Package for Parcel E-2 (ERRG, 2014f) details the Navy's wetlands mitigation approach at HPNS.

2.4. HYDROSTRATIGRAPHY

The hydrostratigraphic units at HPNS include (1) the A-aquifer, (2) the B-aquifer, and (3) the bedrock water-bearing zone. An aquitard composed of Bay Mud separates the A-aquifer from the B-aquifer across most of HPNS. The hydrostratigraphic units at HPNS are generally described below.

The A-aquifer primarily consists of heterogeneous Artificial Fill but may, in select areas of HPNS, also include the following underlying layers: (1) Undifferentiated Upper Sands; (2) sandy units within the uppermost Bay Mud; and (3) the upper weathered bedrock zone. The A-aquifer covers most of HPNS and ranges in thickness from a few feet to more than 50 feet. The A-aquifer is generally unconfined throughout most of HPNS, but semi-confined conditions may exist in places where fine-grained sediments below the water table overlie more permeable materials. Groundwater elevations, as reported in the 2017 groundwater monitoring report (Trevet, Inc., 2018a), range from about -1 to +8 feet relative to msl.

Bay Mud acts as an aquitard that typically separates the A-aquifer from the underlying B aquifer. The Bay Mud deposits consist of highly plastic clay to sandy clay and generally thicken from 0 feet near the historical shoreline to more than 50 feet thick near the bay margin. The Bay Mud aquitard is absent in several locations across HPNS and in areas of bedrock highs.

The B-aquifer consists of Undifferentiated Sediments, in a sequence of relatively thick (about 30 to 40 feet), laterally continuous layers of sand and silty and clayey sand, which are separated by laterally continuous layers of silt and clay. Layers of silts and clay overlie the lower portions of the B-aquifer; therefore, it is less likely to be affected by contamination from site activities. The uppermost B-aquifer generally corresponds to the upper 20- to 40-foot-thick layer of sand and silty sand of Undifferentiated Sedimentary deposits. The B-aquifer is generally confined by the Bay Mud aquitard, which separates it from the A-aquifer across most of HPNS. In areas where the aquitard is absent, the A- and B-aquifers are in hydraulic communication and behave as a single aquifer.

Deeper portions of saturated fractured bedrock that are not in direct contact with the A- or B aquifers are hydrostratigraphically classified as the bedrock water-bearing zone. The fractured, unweathered bedrock is not considered an aquifer because of its limited flow capability and low storage capacity.

Primary sources of recharge for the A-aquifer are infiltration of precipitation and runoff, intrusion of bay water, horizontal flow of groundwater from upgradient areas, and vertical flow of water from the B-aquifer. The primary sources of recharge for the B-aquifer include infiltration of precipitation and runoff and horizontal groundwater flow from upgradient areas. The bedrock water-bearing zone likely discharges into the B-aquifer at upgradient contacts and is recharged by infiltration of precipitation at landward outcrop areas.

2.5. LAND AND RESOURCE USE

This section discusses land and resource use at HPNS, including past and present land uses, anticipated future land uses, and surface water and groundwater use.

2.5.1. Past and Present Land Uses

Bethlehem Steel owned and operated HPNS as a commercial dry dock facility until 1939, when the Navy purchased the property. Quays, docks, and support buildings were built on an expedited wartime schedule to support the shipyard's mission of fleet repair and maintenance. After the end of World War II, the Navy used the berthing facilities at HPNS for ships returning from the Pacific. By 1951, HPNS shifted from operating as a general repair facility to specializing in submarine maintenance and repair. However, the Navy continued to operate Pacific Fleet carrier overhaul and ship maintenance repair facilities at HPNS through the 1960s. In addition to shipyard operations, the Naval Radiological Defense Laboratory (NRDL) occupied buildings at HPNS during the 1950s and 1960s to conduct practical and applied research on radiation decontamination methods and on the effects of radiation on living organisms and natural and synthetic materials. The NRDL ceased operations in 1969. Use of HPNS began to decline steadily in the late 1960s and early 1970s, and HPNS was disestablished as an active Naval facility in 1974 (Naval Sea Systems Command [NAVSEA], 2004).

In 1976, the Navy leased 98 percent of HPNS to a private ship repair company, Triple A Machine Shop, Inc. (Triple A). Triple A leased the property from July 1, 1976, to June 30, 1986. During the lease period, Triple A used dry docks, berths, machine shops, power plants, various offices, and warehouses to repair commercial and Navy vessels. Triple A also subleased portions of the property to various other businesses. In 1986, the Navy resumed occupancy of HPNS. Many of the subtenants under Triple A's lease remained tenants under the Navy's reoccupancy in 1986. Triple A vacated the property in March 1987. Only a few tenants remain at HPNS, primarily the San Francisco Police Department (in Parcel E) and an artist colony (in Parcel B-1).

Various industrial activities at HPNS, including shipbuilding and repair, metal working, degreasing, painting, foundry operations, radiological research, and other industrial operations, have resulted in a broad distribution of chemicals in soil, soil gas, sediment, groundwater, and structures. These chemicals include metals, VOCs, semivolatile organic compounds (SVOCs) (including polycyclic aromatic hydrocarbons [PAHs]), pesticides, polychlorinated biphenyls (PCBs), total petroleum hydrocarbons (TPH), and radionuclides.

2.5.2. Future Land Uses

The anticipated future use of HPNS is described in the San Francisco OCII's HPNS Redevelopment Plan, as currently amended (SFRA, 2010). The redevelopment plan delineates "land use districts" in the subdivision of HPNS and describes the allowable uses within each land use district. The principal uses within the various land use districts include residential; institutional; retail sales and services; office and industrial; multi-media and digital arts; athletic and recreational facilities; civic, arts, and entertainment; and parks and recreation and other open space uses (SFRA, 2010).

2.5.3. Surface Water and Groundwater Use

No permanent surface water features exist at HPNS. Surface water runoff flows to nearby San Francisco Bay or infiltrates into the ground. Groundwater beneath HPNS is not currently used for drinking water, irrigation, or industrial supply. The City and County of San Francisco supplies drinking water to HPNS through its municipal supply from the Hetch Hetchy watershed in the Sierra Nevada.

On September 25, 2003, Water Board staff concurred with the Navy that A-aquifer groundwater at HPNS meets the exception criteria in the State Water Resources Control Board (SWRCB) Resolution No. 88-63, "Sources of Drinking Water"[1]; therefore, groundwater in the A-aquifer is not suitable as a potential source of drinking water. Likewise, on July 29, 2008, Water Board staff concurred with the Navy that B-aquifer groundwater in the central and southern area of Parcel C at HPNS meets the exception criteria in SWRCB Resolution No. 88-63, "Sources of Drinking Water"; therefore, groundwater in the B-aquifer at those locations is not suitable as a potential source of drinking water.

Similar to the evaluation for SWRCB Resolution No. 88-63, the Navy concluded that maximum contaminant levels (MCLs) were not applicable or relevant and appropriate requirements (ARARs) for CERCLA cleanups at HPNS based on an evaluation of site-specific factors (ChaduxTt, 2007; SulTech 2007b and 2008; Barajas & Associates, Inc., 2008b; and ERRG and Shaw Environmental & Infrastructure, Inc. [Shaw] 2011). Results of the evaluation of site-specific factors showed that:

[1] https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/1988/rs1988_0063.pdf

- there is no historical or current use of groundwater as a water supply;
- the City and County of San Francisco will not allow the use of groundwater for drinking water because the city prohibits installation of domestic wells within city boundaries;
- arsenic and other metals occur in A-aquifer groundwater at ambient levels that exceed MCLs, and the cost to reduce concentrations of these chemicals below MCLs would likely be prohibitive and it may be technically impracticable to do so; and
- the proximity of saline groundwater and surface water from San Francisco Bay creates a high potential for saltwater intrusion if significant quantities are produced from the aquifer.

Future drinking water is expected to continue to be supplied by the city's municipal system. The RODs for the various parcels that require RAs all require institutional controls (ICs) to prohibit the use of groundwater; and, consequently, future use of groundwater is expected to be prohibited, except for uses allowed by the RODs (e.g., maintenance of groundwater monitoring wells).

Section 3. Response Action Summary

This section provides the framework for the response actions that have been undertaken at HPNS. This section discusses the basis for taking action, summarizes the initial (pre-ROD) response actions that have occurred and the remedial action objectives (RAOs) and components of the selected remedy for each parcel, and describes the implementation status of the selected remedy for each parcel.

3.1. BASIS FOR TAKING ACTION

Chemicals of concern (COCs) in soil, sediment, soil gas, and groundwater pose potentially unacceptable risk to human health and the environment at HPNS. Human health risk assessments (HHRAs) for the major parcels (i.e., B through F) evaluated potential exposures to industrial and construction workers, as well as future residents and recreational users. Table 1 lists the COCs in contaminated media for each HPNS parcel (i.e., B through F) that have been found to pose an unacceptable risk for carcinogens greater than 10^{-6} or for noncarcinogens with a hazard index (HI) greater than 1. Note that the COCs listed in Table 1 were found to pose unacceptable risks at the time of publication of the remedial investigations (RIs) for each parcel (including IR-07/18), but may no longer pose risks following the various response actions.

Exposure pathways that resulted in the highest levels of unacceptable risk to human health include potential exposure to metals and organic chemicals (especially PAHs and PCBs) in soil and potential exposure to VOCs in soil gas (from either soil or groundwater) via vapor intrusion into indoor air. Potential exposure to radionuclides in soil or structures via direct radiation or windblown dust and potential exposure to VOCs in groundwater if used for domestic use also resulted in unacceptable risks. Potential exposure to metals, PAHs, PCBs, and pesticides in shoreline sediment resulted in the highest levels of unacceptable risk to ecological receptors.

3.2. RESPONSE ACTIONS

The following is a chronology of the initial response actions that led up to the initiation of the CERCLA process at HPNS:

- Between 1946 and 1948, the Radiological Safety Section and NRDL decontaminated and surveyed Operation Crossroads ships and HPNS berths and dry docks.
- In 1955, the NRDL surveys to decommission NRDL buildings.
- In 1969, NRDL conducted a survey for disestablishment of the NRDL.

- Between 1984 and 1988, the Navy conducted multiple basewide investigations, including the initial assessment study, the confirmation study, and the Triple A investigation, to identify potential sources of contamination at HPNS.
- In January 1988, the predecessor to the DTSC (i.e., the Department of Health Services), issued a Remedial Action Order to the Navy and Triple A describing the storage and disposal of hazardous substances at HPNS and requiring them to prepare a scoping document, an RI and Feasibility Study (FS) Work Plan, and a Remedial Action Plan, and to implement the Remedial Action Plan. The order listed the 11 sites identified during the confirmation study, 19 Triple A sites, and a PCB spill area.
- In 1989, EPA placed HPNS on the National Priorities List, making it a Superfund site under CERCLA (as amended by the Superfund Amendments and Reauthorization Act).
- In 1990, the Navy conducted a basewide inventory for HPNS sites that had not been adequately assessed by previous investigations, including buildings, utility lines, equipment that contained PCBs, and other sites determined to be potentially contaminated. Forty sites were recommended for site inspections.
- In 1991, the U.S. Department of Defense listed HPNS for closure. Following remediation, the property was to be transferred to the City and County of San Francisco.
- Between 1987 and 1991, the Navy conducted two basewide air quality investigations to evaluate air quality at HPNS. The first study was a component of a risk assessment for a proposed housing area in Parcel A. The second study was focused on the IR sites defined as of 1991.
- In 1992, the Navy, EPA, and the California Environmental Protection Agency (CalEPA) signed a Federal Facility Agreement (FFA). In the FFA, the 11 sites proposed for characterization during the confirmation study were reclassified within the RI/FS framework of CERCLA into Operable Units, because the Navy's intent was to maintain HPNS as an active facility. The focus of the FFA was subsequently changed to expedite transfer and public reuse of HPNS, so the Navy and regulatory agencies divided HPNS into geographic parcels (A through E).

Several basewide response actions were started prior to the definition of the parcels in 1992, but completed after that time, as listed below.

- Phase II and Phase III Radiological Investigations: Between 1993 and 1997, the Navy conducted radiation surveys for soil, buildings, and structures across HPNS. These investigations provided recommendations for remediation that were considered during development of the RIs.
- Underground Storage Tank (UST) and Aboveground Storage Tank (AST) Closures: Between 1991 and 1993, the Navy removed or closed in place nearly 50 USTs and nearly 100 ASTs from locations across HPNS.
- Removal of PCB-Containing Electrical Equipment: Between 1987 and 1998, the Navy removed 169 transformers and 239 other pieces of electrical equipment that contained elevated concentrations of PCBs from locations across HPNS.
- Sandblast Grit Fixation: Between 1991 and 1995, the Navy collected nearly 5,000 tons of sandblast grit from multiple areas at HPNS. The material was sent to an asphalt plant for reuse in an asphalt mix.

Findings from these initial response actions were incorporated, as appropriate, into additional investigations and studies in each major parcel.

The remainder of this section briefly summarizes the primary pre-ROD activities for each of the major parcels (i.e., B through F) at HPNS. Parcel A is not discussed in this report because the parcel required no action under CERCLA.

3.2.1. Pre-ROD Activities and Remedy Selection at Parcel B (IR-07/18 and Parcels B-1 and B-2)

Activities associated with known or potential contaminant releases at Parcel B (which was later subdivided into IR-07/18 and Parcels B-1 and B-2) were identified, and environmental investigations were conducted to identify and assess the nature and extent of contaminants in the following media of concern: (1) soil, shoreline sediment, and soil gas; (2) groundwater; and (3) radiologically impacted media (i.e., soil and above ground and underground structures). Table 2 summarizes the pre-ROD response actions. The pre-ROD investigations and evaluations provided information to evaluate site risks, identify remediation goals (RGs), develop and evaluate remedial alternatives, and support the remedy selected in the original and amended RODs for Parcel B (Navy, 1997 and 2009a).

The original ROD for Parcel B was amended and finalized in 2009 to address shortcomings in the original selected remedy recognized during implementation (Navy, 2009a). Amended RAOs were established to allow selection of a remedy that protects human health and the environment and is consistent with anticipated future land use. The selected remedy consists of actions to remove or treat significant amounts of contamination and actions to contain the remaining contamination and prevent contact through future monitoring, maintenance, and implementation of ICs. Table 3 summarizes the RAOs, as presented in the Amended ROD, and identifies the components of the selected remedy that address the RAOs.

3.2.2. Pre-ROD Activities and Remedy Selection at Parcel C (Parcels C and UC-2)

Activities associated with known or potential contaminant releases at Parcel C (which was later subdivided into Parcels C and UC-2) were identified, and environmental investigations were conducted to identify and assess the nature and extent of contaminants in the following media of concern at Parcel C: (1) soil, (2) soil gas, (3) groundwater, and (4) radiologically impacted media. Table 4 summarizes the pre-ROD response actions. Parcel C was subdivided into Parcels C and UC-2 in 2009, prior to the issuance of any RODs. As a result, there are multiple RODs to address the two parcels subdivided from the original Parcel C. The pre-ROD investigations and evaluations provided sufficient information to evaluate site risks, identify RGs, develop and evaluate remedial alternatives, and support the remedy selected in the RODs for Parcels C and UC-2 (Navy, 2010b and 2009d, respectively).

The ROD for Parcel C was finalized in September 2010 (Navy, 2010b). The selected remedy consists of actions to remove or treat significant amounts of contamination and actions to contain the remaining contamination and prevent contact through future monitoring, maintenance, and implementation of ICs. Table 5 summarizes the RAOs, as presented in the ROD, and identifies the components of the selected remedy that address the RAOs. In October 2014, the Navy prepared an Explanation of Significant Differences (ESD) to the Final ROD to document changes to the approach for defining the extents of soil to be excavated from Parcel C (Navy, 2014b).

The ROD for Parcel UC-2 was finalized in October 2009 (Navy, 2009d). The selected remedy consists of actions to remove significant amounts of contamination and actions to contain the remaining contamination and prevent contact through future monitoring, maintenance, and implementation of ICs. Table 6 summarizes the RAOs, as presented in the ROD, and identifies the components of the selected remedy that will address the RAOs.

3.2.3. Pre-ROD Activities and Remedy Selection at Parcel D (Parcels D-1, D-2, G, and UC-1)

Activities associated with known or potential contaminant releases at Parcel D (which was later subdivided into Parcels D-1, D-2, G, and UC-1) were identified, and environmental investigations were conducted to identify and assess the nature and extent of contaminants in the following media of concern: (1) soil, (2) soil gas, (3) groundwater, and (4) radiologically impacted media. Table 7 summarizes the pre-ROD response actions. Parcel D was subdivided into Parcels D-1, D-2, G, and UC-1 in 2008, prior to the issuance of any RODs. As a result, there are multiple RODs to address the various parcels subdivided from the original Parcel D. The pre-ROD investigations and evaluations provided sufficient information to evaluate site risks, identify RGs, develop and evaluate remedial alternatives, and support the remedy selected in the RODs for Parcels D-1, D-2, G, and UC-1 (Navy, 2009b, 2009c, and 2010a).

The ROD for Parcels D-1 and UC-1 was finalized in July 2009 (Navy, 2009c). The selected remedy consists of actions to remove or treat significant amounts of contamination and actions to contain the remaining contamination and prevent contact through future monitoring, maintenance, and implementation of ICs. Table 8 summarizes the RAOs, as presented in the amended ROD for Parcels D-1 and UC-1, and identifies the components of the selected remedy that will address the RAOs.

The ROD for Parcel D-2 was finalized in August 2010 (Navy, 2010a). The ROD concluded that no further action was necessary for Parcel D-2. As a result, no RAOs were developed for Parcel D-2.

The ROD for Parcel G was finalized in February 2009 (Navy, 2009b). The selected remedy consists of actions to remove or treat significant amounts of contamination and actions to contain the remaining contamination and prevent contact through future monitoring, maintenance, and implementation of ICs. Table 9 summarizes the RAOs, as presented in the ROD for Parcel G, and identifies the components of the selected remedy that address the RAOs.

The Final ROD for Parcel G placed residential land use restrictions on the areas of Parcel G previously planned for non-residential land use in the SFRA's 1997 Redevelopment Plan, without determining whether residential land uses would be allowable. After approval of the Final ROD, the SFRA adopted an updated Redevelopment Plan in 2010 that includes mixed-use development (including residential use) throughout the entire parcel, provided the use is consistent with land use restrictions (SFRA, 2010).

To support implementation of the 2010 Redevelopment Plan, the OCII prepared a feasibility assessment in November 2016 that analyzed the residual concentrations of COCs in soil using health-based regulatory standards to identify whether the residential land use restrictions could be reduced. The feasibility assessment concluded that current site conditions are appropriate for residential use in most of Parcel G. The feasibility assessment also concluded that areas requiring residential land use restrictions could be reduced, provided that features of the selected remedy (e.g., durable covers and ICs with an operation and maintenance [O&M] plan) remain in place (Langan, 2016). An ESD to the Final ROD was prepared in April 2017 to document the reduction in areas requiring residential land use restrictions, based on the recommendations of the feasibility assessment (Navy, 2017c).

3.2.4. Pre-ROD Activities and Remedy Selection at Parcel E (Parcels E, E-2, and UC-3)

Activities associated with known or potential contaminant releases at Parcel E (which was later subdivided into Parcels E, E-2, and UC-3) were identified, and environmental investigations were conducted to identify and assess the nature and extent of contaminants in the following media of concern at Parcel E: (1) soil and shoreline sediment, (2) soil gas, (3) groundwater, (4) nonaqueous-phase liquid (NAPL) at IR-03, (5) landfill gas, and (6) radiologically impacted media. Table 10 summarizes the pre-ROD response actions. Parcel E-2 was subdivided from Parcel E in 2004. Parcel UC-3 was subdivided from the remainder of Parcel E in 2013. As a result, there are multiple RODs to address the various parcels subdivided from the original Parcel E. The pre-ROD investigations and evaluations provided sufficient information to evaluate site risks, identify RGs, develop and evaluate remedial alternatives, and support the remedies selected in the RODs for Parcels E, E-2, and UC-3 (Navy, 2013e, 2012b, and 2014a, respectively).

The ROD for Parcel E was finalized in December 2013 (Navy, 2013e). The selected remedy consists of actions to remove or treat significant amounts of contamination and actions to contain the remaining contamination and prevent contact through future monitoring, maintenance, and implementation of ICs. Table 11 summarizes the RAOs, as presented in the ROD for Parcel E, and identifies the components of the selected remedy that address the RAOs.

The ROD for Parcel E-2 was finalized in November 2012 (Navy, 2012b). The selected remedy consists of actions to remove or treat significant amounts of contamination and actions to contain the remaining contamination and prevent contact through future monitoring, maintenance, and implementation of ICs. Table 12 summarizes the RAOs, as presented in the ROD for Parcel E-2, and identifies the components of the selected remedy that will address the RAOs.

The ROD for Parcel UC-3 was finalized in January 2014 (Navy, 2014a). The selected remedy consists of actions to remove or treat significant amounts of contamination and actions to contain the remaining contamination and prevent contact through future monitoring, maintenance, and implementation of ICs. Table 13 summarizes the RAOs, as presented in the ROD for Parcel UC-3, and identifies the components of the selected remedy that address the RAOs.

3.2.5. Pre-ROD Activities and Remedy Selection at Parcel F

Activities associated with known or potential contaminant releases at Parcel F were identified, and environmental investigations were conducted to identify and assess the nature and extent of contamination. Table 14 summarizes the pre-ROD response actions at Parcel F. The Proposed Plan for Parcel F was published in April 2018 (Navy, 2018), but the ROD for Parcel F has not been published to date.

3.3. STATUS OF IMPLEMENTATION

This section describes the general status of the development, implementation, and operation (as applicable) of the selected remedies at the IR sites within each HPNS parcel. Figure 2 shows the locations of the IR sites within each HPNS parcel. The selected remedies at most HPNS sites and parcels include implementation of ICs, and Table 15 summarizes the required ICs and their implementation status.

3.3.1. IR-07/18

3.3.1.1. RA Activities and Implementation of ICs

The Navy published the Final RD Package for IR-07/18, which describes the basis of design for the final remedy, in January 2010 (ChaduxTt, 2010a). The remedy components for each contaminated medium at IR-07/18 are described below.

- **Soil, Sediment, and Soil Gas:** The selected remedy for soil consists of (1) construction of a durable cover consisting of a 3-foot soil cover over areas requiring institutional controls (ARICs) for radionuclides; (2) construction of a durable cover consisting of a 2-foot soil cover over non-radiological areas; (3) construction of a durable cover consisting of riprap revetment over the shoreline in IR-07; (4) long-term monitoring (LTM) of soil gas in areas where methane concentrations exceed RGs; and (5) ICs to restrict specific land uses and activities.
- **Groundwater:** The selected remedy for groundwater consists of (1) monitored natural attenuation (MNA) and (2) ICs to restrict specific land uses and activities.
- **Radiologically Impacted Media:** The selected remedy for radiologically impacted media consists of (1) conducting a surface scan for radioactive materials over all of IR-07/18; (2) excavation and offsite disposal of all radiological anomalies exceeding radiological RGs for residential soil to a depth of 1 foot; (3) installation of an orange demarcation layer (2 feet below the final cover surface) within the ARIC for radionuclides; (4) conducting a final surface scan for radioactive materials over the soil cover throughout IR-07/18; (5) short-term groundwater monitoring for radionuclides of concern; and (6) ICs to restrict specific land uses and restrict activities.

Figure 3 identifies the locations of the major remedy components at IR-07/18. Construction of the remedy at IR-07/18 began in June 2010 and was completed in September 2011 (ERRG, 2012a). Construction tasks included excavating shoreline debris and sediment and constructing a revetment structure; radiological scanning of the subgrade surface; installing a soil cover; radiological scanning of the final cover surface; radiological screening and sampling of shoreline debris, shoreline sediment, and excavated soil; and installing fencing and warning signs.

The Navy completed a Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 1 survey of the entire surface of IR-07/18, and the top 1 foot was remediated in place to levels specified in the Amended ROD (Navy, 2009a) to ensure a radiologically cleared surface prior to placement of the final cover.

The shoreline revetment includes, from the bottom up, filter fabric, 6 to 12 inches of filter rock, and 2.5 to 3 feet of riprap. The filter fabric is designed to prevent migration of soil and sediment to San Francisco Bay; the filter rock and riprap layers protect the fabric from damage by wave action.

A soil cover was constructed over most of the remaining surface of IR-07/18. In the area identified in the Amended ROD as radiologically impacted (Navy 2009a), the cover includes, from the bottom up, 1 foot of clean imported soil, a demarcation layer that includes an orange geotextile and metallic demarcation tape placed over the fabric in a 10- by 10-foot grid, and 2 feet of clean imported soil. In areas not identified as radiologically impacted, the cover is composed of 2 feet of clean imported soil. The final cover includes surface completions for groundwater monitoring wells and methane monitoring probes, as well as storm water drainage features.

An asphalt cover, rather than a 2-foot-thick soil cover, was constructed over a small area (about 60 feet by 130 feet) in the southeastern corner of IR-07 to allow for a more gradual transition to the final asphalt cover in the adjoining area of Parcel B-1. The asphalt cover included 2 inches of asphalt over 4 inches of aggregate base course.

About 470 cubic yards of soil from the inland areas and additional sediment and debris (concrete, brick, and metal) from the shoreline were removed because cesium or radium concentrations exceeded the stringent release criteria or because the waste was unable to be scanned and thus was assumed to be low-level radioactive waste (LLRW). No radiological releases were confirmed, and no radiological devices were discovered during any of the radiological surveys. In total, 109 LLRW bins (representing about 1,970 tons of waste) were removed and disposed of off site as LLRW. In addition, about 5,390 tons of nonhazardous waste and 2,940 tons of non-Resource Conservation and Recovery Act hazardous waste were removed and disposed of off site. The California Department of Public Health (CDPH) completed further surface scans at IR-07/18, before and after the soil cover was installed. CDPH concluded that there was no evidence or indication of radiological health and safety concerns based on surface gamma radiation in the surveyed areas of IR-07/18 (CDPH, 2013).

Methane was not detected in any gas monitoring probe in samples collected semiannually since the probes were installed in November 2008 (Innovative Technical Solutions, Inc. [ITSI], 2010c; ERRG, 2012a). The methane probes were decommissioned in 2012 (ERRG, 2012c).

Land use and activity restrictions were designed to limit exposure of future landowners or users of the property to hazardous substances and to maintain the integrity of the remedy. The land use and activity restrictions will be met by controlling access to the property until the time of transfer. The site is currently,

and will remain, enclosed by a perimeter fence with locked gates until transfer to the OCII. The land use and activity restrictions described in the land use control (LUC) RD Report (ChaduxTt, 2010a) will be incorporated into the Quitclaim Deed and Covenant to Restrict Use of Property (CRUP) and will take effect upon transfer to the OCII and issuance of those documents.

3.3.1.2. LTM and Maintenance Activities

Durable Cover Maintenance and IC Compliance

Long-term maintenance requirements are detailed in the O&M Plan for IR-07/18 (ERRG, 2012d). Major inspection items include:

- Security: Condition of fencing and signs, evidence of vandalism or unauthorized access, and condition of roads.
- Soil Cover: Evidence of settlement, cracking, or erosion; evidence of slope failure; signs of burrowing pests; adequacy of vegetative cover; signs of excessive traffic; obstructions in drainage swales and evidence of overflow or erosion; and demarcation layer not exposed.
- Revetment: Evidence of settlement, excessive traffic, or pests; evidence of vandalism or theft of armoring; evidence of wave overtopping; signs of scour or erosion at toe or flanks; and filter fabric not exposed.
- Asphalt Cover: Evidence of settlement, cracking, or holes; evidence of ponding; and evidence of excessive traffic.
- Groundwater Monitoring Wells: Evidence of damage or vandalism, presence of obstructions, and condition of locks and seals (these inspections are performed during the semiannual groundwater sampling events, as described in Section 5.3).
- ICs: No construction of residences or enclosed structures without authorization, no use of groundwater, no growing edible items, no land-disturbing activity or disturbance of remedy components (including no excavation beneath demarcation layer) without authorization, and no damage to security features. (Note: some restricted activities may be conducted provided the requirements of the LUC RD [ChaduxTt, 2010a] are followed.)

Quarterly inspections were conducted in October 2011, January 2012, April 2012, and July 2012 during the first year of LTM and maintenance (ERRG, 2012c). Quarterly inspections were conducted in October 2012, January 2013, April 2013, and July 2013 during the second year of LTM and maintenance (ERRG, 2013h).

The inspection frequency was reduced to semiannual following the second year of LTM and maintenance. Semiannual inspections were conducted in October 2013 and April 2014 during the third year of LTM and maintenance (ERRG, 2014i).

The Navy did not formally inspect IR-07/18 in 2015 and 2016 (i.e., the fourth and fifth years of LTM and maintenance) because it was in the process of securing a new O&M contract for the sites. However, the

Navy did perform informal inspections and maintenance to ensure the integrity of the remedy components. The inspections did not identify any notable deficiencies, so no maintenance or repairs were performed in 2015 and 2016.

In 2017, the Navy reduced the inspection and maintenance frequency to annually for IR-07/18 and shifted the annual inspections from the month of April to the month of October to align the inspections with the start of the wet season in the local area. The Navy also revised its O&M procedures to distribute maintenance activities throughout the year, rather than just at the time of the annual inspections, to ensure the remedies are maintained appropriately. For example, (1) mowing of the durable cover is performed in May to reduce the risk of fire hazard in the summer, (2) swales are cleaned of sediment and debris both before and after the rainy season to ensure proper function, and (3) fences are repaired throughout the year to maintain site security. The most recent annual inspection was conducted in October 2017 during the sixth year of LTM and maintenance (IEJV, 2018a), with the maintenance event occurring throughout 2017. This approach was applied to all parcels in the O&M phase (i.e., Parcels B-1, B-2, C, and G).

Throughout the first 6 years of LTM and maintenance, inspections generally concluded that the remedies remain intact and in good condition and they are functioning as intended. Minor issues encountered included occasional vandalism of the fencing, identification of shallow animal burrows, and minor areas where poor vegetation growth occurred due to damage from site activities and drought. Each of these items was addressed in a timely manner and in accordance with the O&M Plan (ERRG, 2012d).

Each year since remedy completion, the Navy conducted inspections to verify continued compliance with the ICs applicable to IR-07/18. The inspection reports certify that the ICs related to land and groundwater use restrictions are being implemented in accordance with the LUC RD (ChaduxTt, 2010a).

Groundwater Monitoring

Groundwater monitoring is conducted throughout HPNS under the Basewide Groundwater Monitoring Program (BGMP) (CE2-Kleinfelder Joint Venture [JV], 2011b and 2012c; Trevet, Inc., 2017a). The BGMP includes quarterly monitoring of groundwater elevations to evaluate the direction and gradient of groundwater flow and sampling and analysis of COCs at varying frequencies. Periodic monitoring reports (referenced in Appendix A) are published that describe the monitoring results and compare the results to the RGs or trigger levels (TLs) to verify the RAOs for groundwater are being met. TLs were established for protection of the beneficial uses of the bay, including ecological receptors.

The current monitoring program includes semiannual sampling of two monitoring wells (IR07MW24 and IR07MW26A) near the San Francisco Bay margin. These wells are monitored to ensure that COCs in groundwater do not migrate to the bay at concentrations that adversely impact ecological receptors (Navy, 2009a).

The Amended ROD (Navy, 2009a) identified monitoring for the following COCs at IR-07/18: metals (chromium VI, copper, lead, mercury, nickel, and selenium) and radionuclides (cesium-137, plutonium-239, radium-226, and strontium-90). Since at least 2004, concentrations of metals (except for lead) and radionuclides remained less than the TLs and RGs, respectively (Trevet, Inc., 2018c). Lead concentrations exceeded the TL of 14.44 micrograms per liter (µg/L) during one sampling event (September 2017). This is the first time lead concentrations have exceeded the TL in the past 10 years, and lead concentrations during the most recent sampling event (May 2018) were less than the TL. In accordance with the RAMP (ChaduxTt, 2010a), the sporadic nature of this exceedance does not warrant any additional action, but the Navy will continue monitoring for lead in A-aquifer groundwater and will evaluate concentration trends in future monitoring reports.

Monitoring will continue in IR-07/18 in accordance with the RAMP (ChaduxTt, 2010a) and any subsequent modifications made under the BGMP until RGs or TLs are met consistently or until RAOs have been met through other means.

3.3.2. Parcels B-1 and B-2

3.3.2.1. RA Activities and Implementation of ICs

The Navy published the Final RD Package for Parcels B-1 and B-2, which describes the basis of design for the final remedy, in December 2010 (ChaduxTt, 2010d). The RD was subsequently revised, including a revision to the LUC RD completed in July 2011 (ChaduxTt, 2011e and 2011f) and an amendment in September 2012 to address revisions to the revetment design based on an updated stability analysis using new geotechnical data (ChaduxTt, 2012c). The remedy components for each contaminated medium at Parcels B-1 and B-2 are described below.

- **Soil, Sediment, and Soil Gas:** The selected remedy for soil, sediment, and soil gas consists of (1) excavation of soil hot spots where COCs exceeded RGs; (2) construction of a durable cover consisting of a 2-foot soil cover; (3) construction of a durable cover consisting of riprap revetment; (4) construction of a durable cover consisting of 4 inches of aggregate base course overlain by 2 inches of asphaltic concrete; (5) restoration of cracks and penetrations in building foundations; (6) implementation of soil vapor extraction (SVE) at IR-10 to reduce VOC concentrations in soil; and (7) ICs to restrict specific land uses and activities.
- **Groundwater:** The selected remedy for groundwater consists of (1) treatment of VOCs in groundwater at IR-10 through injection of a biological amendment, (2) MNA for remaining VOCs and LTM for metals in groundwater, and (3) ICs to restrict specific land uses and activities.
- **Radiologically Impacted Media:** The selected remedy for radiologically impacted media consists of (1) decontamination or dismantling and offsite disposal of radiologically impacted structures; (2) excavation and offsite disposal of radiologically impacted storm drain and sanitary sewer lines and soil from adjacent impacted areas; and (3) survey and obtain unrestricted release of buildings, former building sites, and radiologically impacted areas.

Figures 4 and 5 identify the locations of major remedy components at Parcels B-1 and B-2. Construction of the remedies in Parcels B-1 and B-2 was phased. Hot spot removal was performed between August 2010 and May 2011 (ERRG, 2011). Other RA activities (durable cover construction, SVE in IR-10 and groundwater injection in IR-10) began in November 2012. The construction of durable covers was completed in September 2013 at Parcel B-1 (ERRG, 2017) and in May 2015 at Parcel B-2 (IEJV, 2018b). The SVE system was constructed between December 2012 and May 2013, and operation of the SVE system is ongoing. Polylactate injection in groundwater at IR-10 was performed between February and March 2013, and post-injection performance monitoring is ongoing (see Section 3.3.2.2).

In total, 143 loose cubic yards of soil was excavated from three hot spot areas in Parcels B-1 and B-2, to address lead and PAHs in soil, and disposed of off site (ERRG, 2011). Excavations were backfilled with clean imported soil.

Shoreline revetment was constructed along approximately 1,800 linear feet of shoreline at IR-23 and IR-26 (ERRG, 2017; IEJV, 2018b). An unforeseen discovery of TPH contamination along a 230-foot section of the IR-26 shoreline (in Parcel B-2) delayed completion of the revetment to allow for the TPH contamination to be delineated and removed. The shoreline revetment includes, from the bottom up, filter fabric, 6 to 12 inches of filter rock, and 2.5 to 3 feet of riprap. The filter fabric is designed to prevent migration of soil and sediment to San Francisco Bay; the filter rock and riprap layers protect the fabric from damage by wave action.

A soil cover was constructed on the hillside portions of Parcel B-1 (ERRG, 2017). The soil cover is composed of 2 feet of clean imported soil. The soil cover includes surface completions for groundwater monitoring wells and stormwater drainage features.

An asphalt cover was constructed over the remaining upland areas of Parcels B-1 and B-2 (ERRG, 2017; IEJV, 2018b). The asphalt cover consists of 4 inches of aggregate base course overlain by 2 inches of asphaltic concrete. Drainage features such as swales, diversion berms, catch basins, and storm drain pipes were incorporated into the asphalt cover to convey stormwater off site.

Cracks and penetrations in building foundations were repaired using a variety of materials, such as concrete, non-shrink grout, and asphaltic concrete, to prevent access to underlying soil (ERRG, 2017; IEJV, 2018b). Additionally, access to soil under buildings (e.g., crawl spaces) was blocked with durable wire mesh.

The existing SVE system in Building 123 at IR-10 consists of a blower, blower motor, electrical panel, SVE wells, vapor monitoring wells, liquid/air separator, transfer pump, liquid storage tank, connection hoses, level switches, system interlocks and controls, and gauges. As part of the RA, the existing SVE system was expanded to include three new SVE wells to maximize the removal of VOCs from the subsurface beneath Building 123 (ERRG, 2015c). The system was also repaired, tested, and

recommissioned for operation prior to its startup in March 2013 (ERRG, 2015c). The information will be documented in a future RACR for IR-10[2].

System operation is ongoing, and approximately 21.7 pounds of VOCs (including 21.1 pounds of trichloroethene [TCE]) have been removed from the subsurface to date. This information will be summarized in a forthcoming technical memorandum describing operation and performance of the system through the end of 2018. In 2017, the system was modified to include a variable frequency motor drive to improve control over the vacuum pressure applied by the system's blower. System operation is monitored and optimized, as required, to maximize its removal efficiency. Optimization measures include targeted operation of SVE wells in the areas of highest contaminant concentrations, pulsed and cycled operations of extraction wells, and passive air venting. SVE operations to date have revealed that the system is operating in diffusion-limited soil conditions, which limits the efficacy of mass removal and results in long rebound times (IEJV, 2017).

Approximately 2,658 pound of polylactate hydrogen release compound primer and 5,490 pounds of polylactate hydrogen release compound were injected into 45 groundwater injection points in March 2013 using an injection tool drill rig (ERRG, 2015c). Approximately 152 pounds of polylactate substrate was injected at each location (approximately 7.6 pounds of polylactate substrate per vertical foot). Post-injection monitoring is currently ongoing under the BGMP (Trevet, Inc., 2018c). The information will be documented in a future RACR for IR-10.

The Third Five-Year Review Report identified an issue regarding mercury concentrations in groundwater within Parcel B-2 (at IR-26 wells IR26MW49A and IR26MW51A) (TriEco-Tt, 2013b). Mercury remained in groundwater at concentrations greater than the TLs despite (1) a removal action conducted from 2000 to 2001 to remove 5,178 cubic yards of mercury-contaminated soil from the area to a maximum depth of 10 feet bgs and (2) a time-critical removal action (TCRA) conducted in 2008 to remove 4,500 cubic yards mercury-contaminated soil to a maximum depth of 16 feet bgs. The Third Five-Year Review Report recommended that (1) groundwater at wells IR26MW49A and IR26MW51A should continue to be monitored semiannually for mercury to evaluate the trend in mercury concentrations, and (2) the mass flux of mercury into the bay in the vicinity of wells IR26MW49A and IR26MW51A should be evaluated (TriEco-Tt, 2013b). Since 2013, groundwater continues to be monitored for mercury at bay margin wells (including wells IR26MW49A and IR26MW51A) under the BGMP. Additionally, in 2015, an evaluation was conducted at IR-26 to estimate the mass discharge of mercury to the bay via groundwater transport (TriEco-Tt, 2016). In-situ treatment of mercury using a stabilizing agent is currently underway (KMEA MACTEC Joint Venture, 2017) to minimize migration of mercury in groundwater to the bay. The results of groundwater treatment and performance monitoring for mercury at IR-26 will be reported in a

[2] To date, SVE remedy implementation and performance has only been formally documented in the Draft RACR for Parcel B-1 (ERRG, 2015c). This document was ultimately revised to exclude the SVE remedy at IR-10 because it was deemed to be incomplete. Operation of the SVE system is ongoing and system performance is documented in internal memoranda to the Navy. The information presented in this report was derived from both the RACR and the internal memoranda. The Navy plans to issue operations and performance monitoring reports to the regulatory agencies on an annual basis starting in 2019.

future Remedial Action Completion Report (RACR). If performance monitoring shows that in-situ treatment is not reducing mercury concentrations as intended, the Navy will recommend next steps (such as further analysis and/or treatment) to address the discharge of mercury to San Francisco Bay from IR-26.

Radiological remediation was started in 2006 and completed in 2010 under a basewide TCRA (Navy, 2006). In total, 65,184 cubic yards of soil was removed from 24,826 linear feet of sanitary sewer and storm drain lines; approximately 2,910 cubic yards of soil was disposed of off site as LLRW. Six radiologically impacted buildings (103, 113, 113A, 130, 140, and 146), three former building sites (114, 142, and 157), and the Building 140 discharge channel were screened and remediated (Tetra Tech EC, Inc. [TtEC], 2012a). All radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs. Section 6.1.6 further discusses the review of radiological work (including the conditions prompting the review), and Section 7 discusses how the review will be used to ensure the radiological remedies remain protective.

3.3.2.2. LTM and Maintenance Activities

Durable Cover Maintenance and IC Compliance

Long-term maintenance requirements are detailed in the O&M Plans for Parcels B-1 and B-2 (ERRG, 2016; IEJV, 2018c). Major inspection items include:

- Security: Condition of fencing and signs, evidence of vandalism or unauthorized access, and condition of roads.
- Soil Cover: Evidence of settlement, cracking, or erosion; evidence of slope failure; signs of burrowing pests; adequacy of vegetative cover; signs of excessive traffic; and obstructions in drainage swales and evidence of overflow or erosion.
- Revetment: Evidence of settlement, excessive traffic, or pests; evidence of vandalism or theft of armoring; evidence of wave overtopping; signs of scour or erosion at toe or flanks; and filter fabric not exposed.
- Asphalt Cover: Evidence of settlement, cracking, or holes; evidence of ponding; and evidence of excessive traffic.
- Groundwater Monitoring Wells: Evidence of damage or vandalism, presence of obstructions, and condition of locks and seals (these inspections are performed during the semiannual groundwater sampling events, as described in Section 5.3).
- ICs: No construction of residences or enclosed structures without authorization, no use of groundwater, no growing edible items, no land-disturbing activity or disturbance of remedy components without authorization, and no damage to security features. (Note: Some restricted activities may be conducted provided that the requirements of the LUC RD [ChaduxTt, 2011e and 2011f] are followed.)

Although RACRs were not published until January 2017 and April 2018 for Parcels B-1 and B-2, respectively, the Navy conducted quarterly inspections and maintenance events for constructed components

of the durable covers remedy in January, April, July, and October 2014 (ERRG, 2014b, 2014d, 2014e, and 2014j). The inspection, maintenance, and monitoring programs were implemented early to ensure the durable cover components remained intact and operated as intended following their construction.

The inspection frequency was reduced to semiannually following the first year of LTM and maintenance. Inspections and maintenance were performed semiannually in April and October 2015 (ERRG, 2015h and 2015k).

The Navy did not formally inspect Parcels B-1 and B-2 in 2016 (i.e., the third year of LTM and maintenance) because it was in the process of securing a new O&M contract for the sites. However, the Navy did perform informal inspections and maintenance to ensure the integrity of the completed remedy components.

The inspection frequency was reduced to annually following the third year of LTM and maintenance. O&M activities were realigned to match those described for IR-07/18 in Section 3.3.1.2.

Throughout the first 4 years of LTM and maintenance, inspections generally concluded that the remedies remain intact and in good condition and they are functioning as intended. Minor issues encountered included occasional vandalism of the fencing, identification of shallow animal burrows in the soil cover, minor damage to the asphalt cover due to overgrowth of weeds and contractor activities, and minor areas of poor vegetation growth due to damage from site activities and drought. Each of these items was addressed in a timely manner and in accordance with the O&M Plans for Parcels B-1 and B-2 (ERRG, 2016; IEJV, 2018c).

In addition to these minor issues, the asphalt and soil covers were compromised in one isolated area due to a leak from an underground water pipeline in August 2015. Following repair of the water line, the asphalt and soil covers were repaired in accordance with the O&M Plan for Parcel B-1 and documented in the Semiannual O&M Report (ERRG, 2015k).

In 2017, the Navy conducted inspections to verify compliance with the ICs applicable to Parcels B-1 and B-2. The inspection reports certify that the ICs are being implemented in accordance with the LUC RD (ChaduxTt, 2011e and 2011f).

Groundwater Monitoring

Groundwater monitoring is conducted throughout HPNS under the BGMP (CE2-Kleinfelder JV, 2011b and 2012c; Trevet, Inc., 2017a). The BGMP includes quarterly monitoring of groundwater elevation to evaluate the direction and gradient of groundwater flow and sampling and analysis of COCs at varying frequencies. Periodic monitoring reports are published that describe the monitoring results and compare the results to the RGs or TLs to verify the RAOs for groundwater are being met. TLs were established for protection of the beneficial uses of the bay, including ecological receptors.

For Parcel B-1, the primary COCs requiring regular groundwater monitoring are VOCs. The VOC plume (primarily TCE and its degradation product vinyl chloride [VC]) at IR-10 is being monitored for changes in concentrations and potential migration toward San Francisco Bay. In accordance with the RAMP (ChaduxTt, 2010d), groundwater monitoring at the IR-10 plume consists of a post-injection monitoring event (completed approximately 4 weeks after injection) and ongoing semiannual monitoring (currently being conducted as part of the BGMP). Results from groundwater monitoring (since the injection of biological amendments in 2013) presented in the most recent semiannual basewide groundwater monitoring report (Trevet, Inc., 2018c) indicate an overall reduction in the concentrations of TCE over time, but more data collection is required to make any definitive determinations about long-term TCE concentration trends. The May 2017 and March 2018 groundwater sampling events were the first two event where TCE concentrations were less than the RG for all monitoring wells sampled. VC concentrations continue to exceed the RG in Parcel B-1 but are generally stable. Appendix D presents a figure depicting select groundwater data (for COCs exceeding the RGs at Parcel B-1) from the first quarter 2018 sampling event.

Performance monitoring also includes analysis for VOCs in soil gas. The resulting data represent a direct measurement of the VOC that will migrate to indoor air and reduce the uncertainty related to partitioning of VOCs in groundwater to the vapor phase. Accordingly, soil gas data are more useful than groundwater data in evaluating the treatment remedy's performance in reducing the vapor intrusion risk. Performance monitoring (of both groundwater and soil gas) for the in-situ treatment remedy at IR-10 continues, and more definitive results will be summarized in future technical publications.

The Navy conducted an investigation in August 2017 to evaluate whether per- and polyfluoroalkyl substances (PFAS) are present in groundwater at IR-10 within Parcel B-1 as a result of historical uses (Trevet, Inc., 2018b). IR-10 was one of two sites at HPNS (along with IR-09 in Parcel G; see Section 3.3.9.2) with past uses (i.e., metal finishing) that indicated the potential for PFAS to be present in groundwater. At IR-10, monitoring wells IR10MW28A, IR10MW13A1, and IR10MW31A1 were analyzed for PFAS compounds, including perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), combined PFOA and PFOS, and perfluorobutane sulfonate (PFBS). PFOA and PFOS were detected in one monitoring well (IR10MW28A) at concentrations less than the federal screening criterion (FSC) of 70 nanograms per liter (ng/L). PFBS was detected in one monitoring well (IR10MW31A1) at an estimated concentration of 2.28 ng/L, well below the FSC of 380 ng/L. Concentrations of PFOA, PFOS, combined PFOA and PFOS, and PFBS were less than their respective FSCs during the PFAS groundwater investigation. Based on available data, groundwater at IR-10 has not been affected by PFAS.

For Parcel B-2, the COCs requiring regular groundwater monitoring are metals and the VOC dichlorodifluoromethane (also known as Freon-12). Freon-12 is monitored in one monitoring well (IR26MW41A) to evaluate the potential risk to human health based on vapor intrusion. Freon-12 concentrations at well IR26MW41A consistently exceed the RG; however, historical data indicates that the elevated Freon-12 concentrations are stable and localized (Trevet, Inc., 2018c). Mercury concentrations also consistently exceeded the TL of 0.6 µg/L in two monitoring wells (IR26MW49A and IR26MW51A),

with sporadic exceedances in one additional well (PA50MW02A). At IR-26, in-situ stabilization within the saturated zone is currently being performed to reduce mercury concentrations in groundwater and minimize migration of mercury in groundwater to San Francisco Bay (KMEA MACTEC Joint Venture, 2017). Performance monitoring of the in-situ treatment remedy in IR-26 is underway, and results will be summarized in future technical publications. Appendix D presents a figure depicting select groundwater data (for COCs exceeding the RGs or TLs at Parcel B-2) from the first quarter 2018 sampling event.

Monitoring will continue in Parcels B-1 and B-2 in accordance with the RAMP and subsequent modifications made under the BGMP until RGs or TLs are met consistently or until RAOs have been met through other means.

3.3.3. Parcel C

3.3.3.1. RA Activities and Implementation of ICs

The Navy published the Final RD Package for Parcel C, which describes the basis of design for the final remedy, in October 2012 (CH2M HILL Kleinfelder, A Joint Venture [KCH], 2012). Revisions to the design include an ESD completed in October 2014 that documented changes to soil excavation boundaries as a result of applying tiered action levels for select COCs based on risk identified in a screening-level HHRA rather than excavating to RGs in all excavation locations (Navy, 2014b). The remedy components for each contaminated medium are described below.

- **Soil and Soil Gas:** The selected remedy for soil and soil gas consists of (1) excavation of soil hot spots where COCs exceed RGs; (2) construction of a durable cover consisting of a 2-foot-thick vegetated soil cover; (3) construction of a durable cover consisting of shoreline armoring; (4) construction of a durable cover consisting of 4 inches of aggregate base course overlain by 2 inches of asphaltic concrete; (5) restoration of cracks and penetrations in building foundations; (6) implementation of SVE at eight locations to reduce VOC concentrations in soil; and (7) ICs to restrict specific land uses and activities.
- **Groundwater:** The selected remedy for groundwater consists of (1) treatment of VOCs in groundwater plumes through injection of zero-valent iron (ZVI) or biological amendments, (2) MNA for remaining VOCs and LTM for metals in groundwater, and (3) ICs to restrict specific land uses and activities.
- **Radiologically Impacted Media:** The selected remedy for radiologically impacted media consists of (1) decontamination or dismantling and offsite disposal of radiologically impacted structures; (2) excavation and offsite disposal of radiologically impacted storm drain and sanitary sewer lines and soil from adjacent impacted areas; and (3) survey and obtain unrestricted release of buildings, former building sites, and radiologically impacted areas.

Figure 6 identifies the locations of the major remedy components at Parcel C. Implementation of the remedies in Parcel C is being phased and is still ongoing. Hotspot removal from 18 excavation areas was performed between 2013 and 2015 (APTIM Federal Services, LLC [APTIM], 2018b). The construction of durable covers began in June 2015 and was completed in May 2016 (TtEC, 2017c). Construction and

operation of five SVE systems within Remedial Units (RU)-C1, RU-C4, and RU-C5 began in 2013, and operation of the SVE systems is ongoing, although operation has been temporarily suspended to allow for additional site characterization and remediation. ZVI and in-situ bioremediation (ISB) injections at groundwater plumes were performed between 2013 and 2017, and post-injection performance monitoring is ongoing (see Section 3.3.3.2).

In total, 28,261 bank cubic yards of soil was excavated from 18 hotspot areas in Parcel C, to remove soil with COC concentrations greater than RGs, and disposed of at an offsite facility (APTIM, 2018b). During the RA, 12 previously remediated underground storage tanks were confirmed to be removed or closed in place. Excavations were backfilled with clean imported soil. To date, all hotspot excavation activities have been completed, except for excavations to be performed within Buildings 251.

Shoreline armoring was constructed along approximately 80 linear feet of deteriorated seawall northeast of Building 231 (TtEC, 2017c). The shoreline armoring includes, from the bottom up, filter fabric, a 6-inch minimum layer of filter rock, and a 3-foot minimum layer of riprap. The filter fabric is designed to prevent migration of soil to San Francisco Bay; the filter rock and riprap layers protect the fabric from damage by wave action.

A soil cover was constructed on the hillside in the northwest corner of Parcel C (TtEC, 2017c). The soil cover is composed of 2 feet of clean imported soil. The soil cover includes surface completions for groundwater monitoring wells.

An asphalt cover was constructed over the remaining areas of the site (TtEC, 2017c). Most of Parcel C was covered with degraded asphalt pavement prior to the durable covers RA, and the existing asphalt pavement was repaired or replaced as needed to create a continuous intact cover. Areas in which the existing asphalt cover required minor repair were typically overlain with new asphaltic concrete to achieve a 2-inch-thick cover. Asphalt replacement, where needed, consisted of 4 inches of aggregate base course overlain by 2 inches of asphaltic concrete. Drainage features such as swales, catch basins, and storm drain pipes were incorporated into the asphalt cover to convey stormwater off site.

Cracks and penetrations in building foundations were repaired using a variety of materials, such as concrete, non-shrink grout, and asphaltic concrete, to prevent access to underlying soil (TtEC, 2017c). Building foundations that could not be restored or repaired (e.g., historical buildings) were secured using a combination of steel plates, framed plywood walls, wire mesh, and/or chain link fence to prevent access. Additionally, access to soil under buildings (e.g., crawlspaces and vaults) was blocked with durable wire mesh or secured with steel ties.

Five SVE systems were installed to remediate eight soil vapor areas (1 through 8) that overlie groundwater VOC plumes (APTIM, 2018b). Each system includes a blower, blower motor, main control panel, SVE wells, vapor monitoring wells, liquid/air separator, transfer pump and liquid storage tank, conveyance piping and connection hoses, granular activated carbon vessels, level switches, system interlocks and

controls, and gauges. The SVE systems were operated at Areas 1, 3, 6, 7, and 8 beginning in August 2014, and system operation, monitoring, performance sampling, and optimization activities were performed through February 2016; at which time, operation was temporarily ceased to transfer SVE operations to a new contractor. The SVE system at Area 3 was expanded in March 2016 to also treat soil vapor at Areas 4 and 5. System operation has not yet been performed at Area 2. Additional SVE operations were performed in Areas 1, 3, 4, 5, 6, 7, and 8 between May and November 2016 (ECC-Insight, LLC and CDM Smith, 2019). The performance of these SVE systems to date is described below.

- Area 1: Approximately 3.2 pounds of VOCs (predominantly TCE) has been removed
- Areas 3, 4, and 5: Approximately 1.7 pounds of VOCs (predominantly tetrachloroethene [PCE] and TCE) has been removed
- Areas 6 and 7: Approximately 4.2 pounds of VOCs (predominantly TCE) has been removed
- Area 8: Approximately 22 pounds of VOCs (predominantly PCE and TCE) has been removed

Operation of the SVE systems is monitored and optimized, as required, to maximize its removal efficiency. Following asymptotic conditions, optimization measures include targeted operation of SVE wells in the areas of highest contaminant concentrations, pulsed and cycled operations of extraction wells, and adjusting operating vacuum pressures to minimize water entrainment from the SVE wells.

Between 2014 and 2017, active groundwater treatment using ZVI, anaerobic ISB, and/or aerobic ISB was implemented at plumes in RU-C1, RU-C4, and RU-C5 (APTIM, 2018b). Anaerobic ISB consisted of direct injection of (1) an anaerobic organic substrate (sodium lactate) with bioaugmentation (*Dehalococcoides*, specifically SDC-9™) or (2) food-grade molasses as a substrate. Aerobic ISB consisted of direct injection of an oxygen-releasing compound (PermeOx Ultra®). The following list summarizes the various active groundwater treatment methods that were implemented:

- Approximately 206,183 pounds of micro-scale ZVI powder mixed with water was injected into 40 points to primarily treat chlorinated VOCs (CVOCs)
- Approximately 114,500 gallons of sodium lactate and SDC-9™ mixture was injected into 122 points to primarily treat CVOCs
- Approximately 16,064 gallons of molasses and water solution was injected into 17 points to primarily treat chromium VI
- Approximately 5,795 pounds of PermeOx Ultra® mixed with water was injected into 8 points to primarily treat naphthalene, chlorobenzene, and dichlorobenzene compounds

The maximum injection depth varied from 25 feet bgs to as deep as 49 feet bgs with injections occurring at 3-foot intervals. Post-injection groundwater monitoring is currently being performed under the BGMP.

Treatment work in RU-C2 was initiated in 2014, but has not been completed. Currently, additional in-situ active groundwater treatment and source removal is planned for RU-C1 and RU-C2 (ECC-Insight, LLC

and CDM Smith, 2017c). Active groundwater treatment will consist of additional ZVI and ISB injections to treat CVOCs and/or carbon tetrachloride. In addition, over-excavation is required to meet the residential RGs in soil in Building 251 and removal of sumps is planned in Building 253.

Radiological remediation at Parcel C began in 2007 under a basewide TCRA (Navy, 2006) and continued as part of the RA. Radiological surveys and remediation have been performed for all radiologically impacted buildings (203, 205 and discharge tunnel, 211, 214, 224, 241, 253, 271, and 272), storm drains, and sanitary sewers, except for Buildings 211 and 253. In total, 37,572 cubic yards of soil was removed from 19,260 linear feet of sanitary sewer and storm drain lines; approximately 987 cubic yards of soil was disposed off site as LLRW (TtEC, 2016d). All previous radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs. Section 6.1.6 further discusses the review of radiological work (including the conditions prompting the review), and Section 7 discusses how the review will be used to ensure the radiological remedies remain protective. Radiological surveys and related remediation at Buildings 211 and 253 are still in the planning stages and will be completed in coordination with the regulatory agencies.

3.3.3.2. LTM and Maintenance Activities

Durable Cover Maintenance and IC Compliance

Long-term maintenance requirements are described in the O&M Plan for Parcel C (TtEC, 2017b). The O&M Plan includes inspection items that are similar to those described for Parcels B-1 and B-2 (Section 3.3.2.2).

Although the Parcel C RACR for the durable covers was not published until March 2017, the Navy conducted quarterly inspections and maintenance events for constructed components of the durable covers remedy in July 2016, October 2016, January 2017, and March 2017 (TtEC, 2017c). The inspection, maintenance, and monitoring programs were implemented early to ensure that the durable cover components remained intact and operated as intended following their construction.

The inspection frequency was reduced to annually following the first year of LTM and maintenance. O&M activities were realigned to match those described for IR-07/18 in Section 3.3.1.2.

Throughout the first 2 years of LTM and maintenance, inspections generally concluded that the remedies remain intact and in good condition and they are functioning as intended. Minor issues encountered included occasional vandalism of the fencing, minor damage to the asphalt cover due to overgrowth of weeds and contractor activities, minor damage to the asphalt cover due to subsidence along seawalls, and minor areas of poor vegetation growth due to damage from site activities and drought. Each of these items was addressed in a timely manner and in accordance with the O&M Plan (TtEC, 2017b).

In 2017, the Navy conducted inspections to verify compliance with the ICs applicable to Parcel C. The inspection reports certify that the ICs are being implemented in accordance with the LUC RD (KCH, 2012).

Groundwater Monitoring

Groundwater monitoring is conducted throughout HPNS under the BGMP (CE2-Kleinfelder JV, 2011b and 2012c; Trevet, Inc., 2017a). The BGMP includes quarterly monitoring of groundwater elevations to evaluate the direction and gradient of groundwater flow and sampling and analysis of COCs at varying frequencies. Periodic monitoring reports are published that describe the monitoring results and compare the results to the RGs or TLs to verify the RAOs for groundwater are being met (Trevet, Inc., 2018c).

Parcel C is currently monitored in support of the selected remedy specified in the ROD, with monitoring recommendations provided in the RD (Navy, 2010b; KCH, 2012). Groundwater samples are collected semiannually from 75 monitoring wells within Parcel C and analyzed for MNA parameters, metals, VOCs, SVOCs, and total TPH. Parcel C contains four RUs (C1, C2, C4 and C5). Each RU has a unique list of COCs and chemicals of ecological concern (COECs). In general, the COCs and COECs in Parcel C include metals (including chromium VI), VOCs, and TPH (added in 2017).

Additional in-situ treatment for VOCs and associated performance monitoring is underway at the RU plumes in Parcel C. In accordance with the monitoring recommendations in the RD (KCH, 2012) and the work plan for the in-situ treatment (ECC-Insight, LLC and CDM Smith, 2017c), treatment and performance monitoring is scheduled to occur at approximately 1, 3, 6, 9, and 12 months following completion of ZVI or biological substrate injections at each RU plume. Long-term MNA monitoring will be implemented under the BGMP following reduction of COC concentrations to below active treatment criteria specified in the RD (KCH, 2012). A future optimization memorandum update to the BGMP will include the post-injection performance monitoring results and provide details for the long-term monitoring to be implemented to achieve the RAOs (ECC-Insight, LLC and CDM Smith, 2017c). Appendix D presents figures depicting select groundwater data (for COCs exceeding the RGs at Parcel C) from the first quarter 2018 sampling event.

Performance monitoring also includes analysis for VOCs in soil gas. The resulting data represent a direct measurement of the VOC that will migrate to indoor air and reduce the uncertainty related to partitioning of VOCs in groundwater to the vapor phase. Accordingly, soil gas data are more useful than groundwater data in evaluating the treatment remedy's performance in reducing the vapor intrusion risk. Performance monitoring results (of both groundwater and soil gas) will be summarized in future technical publications (ECC-Insight, LLC and CDM Smith, 2017c) that are expected to be issued by late 2019 or early 2020.

Since 2014, concentrations of chromium VI has generally remained below the respective TLs, with one isolated exceedance reported in May 2017 (Trevet, Inc., 2018c). The concentration of total TPH exceeded the RGs in 2 of 14 wells sampled during the two monitoring events since TPH was added to the list of COECs. The sporadic nature of these exceedances do not warrant any additional action, but the Navy will continue monitoring for chromium VI and total TPH in groundwater and will evaluate concentration trends in future monitoring reports.

3.3.4. Parcel D-1

3.3.4.1. RA Activities and Implementation of ICs

The Navy published the Final RD Package for Parcel D-1, which describes the basis of design for the final remedy, in February 2011 (ChaduxTt, 2011d). The remedy components for each contaminated medium are described below.

- **Soil and Soil Gas:** The selected remedy for soil and soil gas consists of (1) excavation of soil hot spots and removal of soil stockpiles where COCs exceed RGs; (2) repair of durable asphalt covers with minor damage; (3) construction of a durable cover consisting of 2 inches of new asphaltic concrete placed over new or existing aggregate base course; (4) restoration of cracks and penetrations in building foundations; (5) construction of a durable cover consisting of riprap stabilization in several small areas adjacent to existing seawalls; (6) soil gas surveys to evaluate vapor intrusion risks and assess the need for additional remedial activities or ARICs; and (7) ICs to restrict specific land uses and activities.
- **Groundwater:** The selected remedy for groundwater consists of (1) treatment of VOCs in groundwater at the IR-71 plume using ISB or ZVI, (2) MNA, and (3) ICs to restrict specific land uses and activities.
- **Radiologically Impacted Media:** The selected remedy for radiologically impacted media consists of (1) decontamination or dismantling and offsite disposal of radiologically impacted structures; (2) excavation and offsite disposal of radiologically impacted storm drain and sanitary sewer lines and soil from adjacent impacted areas; and (3) survey and obtain unrestricted release of buildings, former building sites, and radiologically impacted areas.

Figure 7 identifies the locations of major remedy components at Parcel D-1. Completion of the RA activities in Parcel D-1 occurred in phases. Soil hot spots and stockpiles were removed in two phases: the first phase was conducted between August 2010 and May 2011 (ERRG, 2011), and the second phase was conducted between May 2013 and July 2013 (ERRG, 2014c). A soil gas study was completed in 2013 (Sealaska Environmental Services, LLC [SES], 2013); results from the study were used to evaluate potential risk to human health via vapor intrusion and to assess the need for ICs related to VOC vapors. Radiological removals and subsequent construction of the durable covers at Parcel D-1 are being implemented in two phases. The Phase I radiological remediation was performed under a basewide TCRA between 2010 and 2014 (Shaw, 2014a), and the Phase II radiological remediation was performed in 2016 as part of the RA (Gilbane Federal, 2018a). Durable covers were constructed over the Phase I area in 2017 and over the Phase II area in 2018.

The pre-ROD groundwater treatability study included an assessment of risks to human health and the environment from metals and VOCs in two groundwater plumes at Parcel D-1. The two plumes (known as the IR-71 West and IR-71 East plumes) originate in Parcel G and extend into Parcel D-1. The treatability study concluded the IR-71 West plume required treatment with ZVI to address chloroform in groundwater. Approximately 136,000 pounds of ZVI was injected into 88 groundwater injection points in the IR-71 West plume between October and December 2008, prior to the publication of the ROD. A post-injection

groundwater and soil vapor assessment was conducted between December 2008 and April 2009 to verify the effectiveness of the ZVI treatment (Alliance, 2010). The risk assessment completed during the treatability study demonstrated that the IR-71 East plume did not require treatment to address VOCs in groundwater (Alliance, 2010). Post-ROD groundwater monitoring for metals and VOCs is currently ongoing under the BGMP (see Section 3.3.4.2).

In total, approximately 237 loose cubic yards of soil was excavated from six hotspot areas in Parcel D-1 to address PAH contamination in soil. Four of the hotspot areas were removed during the first phase of the RA conducted between August 2010 and May 2011. At that time, two of the hotspot areas were inaccessible because they were located within an active radiological screening yard. The two remaining hotspot areas were removed during the second phase of the RA conducted between May 2013 and July 2013, when the radiological screening yard was inactive. All excavated soil was disposed of off site and the excavations were backfilled with clean imported soil (ERRG, 2011 and 2014c). One soil stockpile, totaling 75 cubic yards, identified in the RD was also removed and disposed of off site (ERRG, 2011).

Radiological remediation was performed in two phases. Phase I, completed in 2014, included radiological remediation and surveys of the northern portion of Parcel D-1, including Gun Mole Pier, South Pier, Buildings 274 and 383, former building sites 313/313A/322, and a portion of the storm drain and sanitary sewer system. Phase I included removal of 18,320 cubic yards of soil from 12,957 linear feet of sanitary sewer and storm drain lines (Shaw, 2014a). Phase II included radiological remediation and surveys of the remainder of Parcel D-1 (i.e., the southern portion of Parcel D-1) (Gilbane Federal, 2018a). Both phases of radiological remediation are complete. However, the fill history raises the potential for radioactive objects to be encountered at a portion of Parcel D-1, and the Navy is proposing ICs related to radionuclides in this area. The ICs for radionuclides will be defined in a forthcoming addendum to the LUC RD for Parcel D-1. All radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs. Section 6.1.6 further discusses the review of radiological work (including the conditions prompting the review), and Section 7 discusses how the review will be used to ensure the radiological remedies remain protective.

Durable covers, consisting of a combination of repaired and newly constructed asphalt pavement covers, existing building foundations, and riprap stabilization, have been constructed over the Phase I portion of Parcel D-1 (APTIM, 2018c). The existing asphalt pavement was repaired, where possible, using a combination of crack treatment, patching, and thin asphalt overlays to restore the integrity of the cover. A new asphalt pavement cover, consisting of 4 inches of aggregate base course overlain by 2 inches of asphaltic concrete, was installed over areas of the site where existing asphalt pavement was nonexistent or unrepairable. Existing concrete building foundations were restored by sealing cracks and patching openings to prevent access to the underlying soil. Degraded sections of the existing seawall were stabilized by installing riprap-filled gabion baskets in the void spaces adjacent to the seawall prior to constructing the asphalt pavement cover over the areas. A durable cover consisting of 1 foot of riprap overlying a layer of filter fabric was constructed over several small areas of eroded soil near the ends of the piers.

During Phase II, durable covers were recently constructed over the remaining portion of Parcel D-1 in the same manner as during Phase I described above, in accordance with the Parcel D-1 Remedial Action Work Plan (RAWP) (CB&I Federal Services LLC, 2014 and 2016). The RACR for the Phase II durable covers was being prepared at this time this report was published.

3.3.4.2. LTM and Maintenance Activities

Durable Cover Maintenance and IC Compliance

Long-term maintenance requirements are detailed in the O&M Plan for Parcel D-1 (APTIM, 2018a). The O&M Plan includes inspection items that are similar to those described for Parcels B-1 and B-2 (see Section 3.3.2.2).

The inspection and maintenance of durable covers in the Phase I area were documented in an April 2018 report (APTIM, 2018d). The durable covers in the Phase II area were recently completed, and the parcel-wide inspection and maintenance program was initiated in 2019.

Groundwater Monitoring

Groundwater monitoring is conducted throughout HPNS under the BGMP (CE2-Kleinfelder JV, 2011b and 2012c; Trevet, Inc., 2017a). The BGMP includes quarterly monitoring of groundwater elevations to evaluate the direction and gradient of groundwater flow and sampling and analysis of COCs at varying frequencies. Periodic monitoring reports are published that describe the monitoring results and compare the results to the RGs to verify the RAOs for groundwater are being met.

For Parcel D-1, the COCs identified in groundwater are metals and VOCs. The list of specific COCs is presented in the ROD (Navy, 2009c). In 2012, the VOC monitoring program at Parcel D-1 was discontinued at most monitoring wells because concentrations were less than the RGs and were stable or decreasing (CE2-Kleinfelder JV, 2012b). After 2012, the monitoring program continued to include the analysis of metals, as well as the analysis of VOCs at one monitoring well at Parcel D-1. In May 2017, no COCs exceeded their respective RGs at Parcel D-1 (Trevet, Inc., 2018a).

The current monitoring program includes semiannual collection of groundwater samples, for analysis of metals, from three monitoring wells (IR17MW13A, IR22MW16A, and IR55MW02A) near the San Francisco Bay margin. These wells are monitored to ensure that COCs in groundwater do not migrate to San Francisco Bay at concentrations that adversely impact ecological receptors. Additionally, a groundwater sample is collected for analysis of VOCs from one monitoring well (IR71MW20A) to monitor VOC concentrations in the IR-71 East plume. Appendix D presents a figure depicting select groundwater data from the first quarter 2018 sampling event, which document that no COCs exceed the RGs at Parcel D-1.

With two isolated exceptions (silver in July 2008 and lead in September 2015), no COCs have been reported at concentrations exceeding their respective RGs or TLs in groundwater since 2004 (Trevet, Inc., 2018c). The RAOs have been met for Parcel D-1. Current monitoring of these wells will continue in accordance with the RAMP (ChaduxTt, 2011d) and subsequent modifications made under the BGMP.

3.3.5. Parcel D-2

3.3.5.1. RA Activities and Implementation of ICs

The ROD for Parcel D-2 was finalized in August 2010 (Navy, 2010a). The ROD concluded that no further action was necessary for Parcel D-2. Radiological remediation was performed in 2009 as part of a basewide TCRA (Navy, 2006). In total, 1,988 linear feet of trench and 1,434 cubic yards of soil were excavated; approximately 45 cubic yards of soil was disposed of off site as LLRW (TtEC, 2011c). One radiologically impacted building (Building 813) was screened and remediated. All radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs. Section 6.1.6 further discusses the review of radiological work (including the conditions prompting the review), and Section 7 discusses how the review will be used to ensure the radiological remedies remain protective.

3.3.5.2. LTM and Maintenance Activities

No LTM and maintenance activities are required at Parcel D-2. Parcel D-2 was transferred out of federal ownership to the OCII in late 2015.

3.3.6. Parcel E

3.3.6.1. RA Activities and Implementation of ICs

The RD for Parcel E was started in 2014 and included several pre-design investigations, the last of which was completed in 2015. In addition, a treatability study was implemented at IR-03 (in 2013 and 2014) to evaluate NAPL treatment using in-situ thermal remediation (ISTR) and in-situ solidification/stabilization (ISS) technologies. The studies were conducted within the IR-03 NAPL zone to assess the ability of each technology to achieve the RAOs and provide the information necessary for the full-scale RD (Cabrera Insight Joint Venture [CIJV] and CDM Smith, 2016a).

Approximately 2,453 gallons of NAPL was mobilized and recovered during operation of the ISTR system, which operated for 153 days over an approximate 1,900-square-foot area that extended to 25 feet bgs. The study demonstrated that ISTR technology was able to remove significant volumes of NAPL, but also identified inefficiencies of the ISTR system that would need to be accounted for during full-scale RD. The ISS study consisted of injecting reagents and homogenizing the subsurface soil to create five overlapping columns. Approximately 1,350 cubic feet of soil was mixed as part of the ISS study. Physical testing demonstrated that ISS would significantly reduce the mobility and leaching of NAPL from the highly saturated mobile NAPL zone (CIJV and CDM Smith, 2016b).

In the analysis provided in the RD, ISS was identified as the better technology for addressing NAPL and achieving the RAOs based on effectiveness, implementability, sustainability, and cost. Accordingly, the ISS was selected for full-scale NAPL treatment within the mobile NAPL zone at IR-03. The Navy published the Final RD Package for Parcel E, which describes the basis of design for the final remedy, in May 2018 (Construction Engineering Services, LLC [CES], 2018a). The remedy components for each contaminated medium are described below.

- **Soil, Soil Gas, and Shoreline Sediment:** The selected remedy for soil, soil gas, and shoreline sediment consists of (1) removal and disposal of contaminated soil in selected areas (referred to as Tier 1, Tier 2, and TPH locations[3]) that contain nonradioactive chemicals (including metals, SVOCs, PCBs, and TPH[4]) at concentrations exceeding risk-based levels, as well as separation and disposal of materials and soil with radiological contamination found in these areas; (2) closure of remaining portions of the steam and fuel line system; (3) construction of a durable cover consisting of 2 feet of soil over future open space areas; (4) construction of a durable cover consisting of new or restored asphalt or concrete over areas that will be part of the future Mixed-Use District; (5) implementation of SVE at Building 406 to treat VOC contamination in soil and soil gas; (6) soil gas monitoring at VOC plumes, the IR-12 debris removal area, and in future mixed-use redevelopment areas where VOCs are present in soil; (7) removal and disposal of contaminated shoreline sediment and installation of shoreline protection materials to prevent exposure to remaining contaminants in shoreline sediment; and (8) ICs to restrict specific land uses and activities.
- **Groundwater:** The selected remedy for groundwater consists of (1) treatment of VOCs in groundwater through injection of a biological amendment, (2) construction of a below-ground barrier in IR-02 to limit migration of groundwater contaminants into San Francisco Bay, (3) MNA, and (4) ICs to restrict specific land uses and activities.
- **NAPL at IR-03:** The selected remedy for NAPL at IR-03 consists of (1) removal or treatment of the NAPL source at IR-03, (2) construction of a below-ground barrier to limit migration of NAPL and contaminated groundwater into San Francisco Bay, (3) treatment of VOC and TPH contamination in groundwater through injection of a biological amendment, (4) MNA, and (5) ICs to restrict specific land uses and activities.
- **Radiologically Impacted Media:** The selected remedy for radiologically impacted media outside of IR-02 and IR-03 consists of (1) decontamination or dismantling and offsite disposal of radiologically impacted structures; (2) excavation and offsite disposal of radiologically impacted storm drain and sanitary sewer lines and soil from adjacent impacted areas; and (3) survey and obtain unrestricted release of buildings, former building sites, and radiologically impacted areas. The selected remedy for radiologically impacted media at IR-02 and IR-03 consists of (1) a radiological scan of the entire area to a depth of at least 1 foot; (2) separation and disposal of materials and soil with radiological contamination found during the surveys; (3) construction of a 2-foot-thick soil cover to prevent exposure to remaining contaminants (the soil cover at IR-02 and

[3] Tier 1 locations contain COCs at concentrations greater than 10 times the RGs. Tier 2 locations contain COCs at concentrations greater than 5 times the RGs. TPH locations contain TPH (commingled with CERCLA-regulated chemicals) at concentrations exceeding the petroleum source criterion (3,500 milligrams per kilogram).

[4] These chemical groups comprise the Tier 1, Tier 2, and TPH locations proposed for removal. Dioxins and furans are not included in this list because these chemicals are not found at concentrations greater than 5 times the RGs.

IR-03 would also include a demarcation layer to mark the boundary between the existing surface and the soil cover); (4) ICs (specific to radionuclides) to restrict specific land uses and activities; and (5) monitoring of groundwater to demonstrate, consistent with the findings of previous radiological investigations, that radionuclides are not present in groundwater at activity levels that are both statistically significant and pose an unacceptable risk to human health and the environment.

Figure 8 identifies the locations of the major remedy components at Parcel E. Radiological remediation at Parcel E began under a basewide TCRA (Navy, 2006), and this previous radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs (see Section 6.1.6 for further information). Additional radiological remediation will be completed as part of the RA. The RA at Parcel E will be implemented in phases. At the time this report was prepared, the RAWPs were being prepared for the first three phases of the RA, and RA fieldwork is planned to begin in late 2018. The following paragraphs briefly describe the planned activities during the first three phases of the RA.

Phase 1 RA for Parcel E

The Phase 1 RA for Parcel E will consist of the following activities:

- Remove and dispose of contaminated soil in Tier 1, Tier 2, and TPH locations (except for locations within the proposed shoreline protection)
- Perform supplemental soil gas monitoring at the debris removal area within IR-12 and in areas planned for mixed use where concerns continue about residual VOCs in soil
- Investigate and close remaining portions of the steam and fuel line system to address potential sources of contamination
- Treat VOC contamination in groundwater at inland plumes using injected biological nutrients (or potentially a mixture of biological nutrients and ZVI) to accelerate the breakdown of VOCs to less toxic compounds

The Phase 1 RA also includes excavation of VOCs in vadose zone soil at two locations (IR-04 and south of Building 406) that are adjacent to planned excavations at Tier 1, Tier 2, and TPH locations. The Phase 1 RA also includes plans for installing an SVE system to address VOCs in the vadose zone under Building 406. However, contingency excavation may be implemented under Building 406 if the structure is demolished as part of the redevelopment process and the contingency excavation can be coordinated with the planned excavation south of Building 406. The Phase 1 RAWP for Parcel E was started in 2017, and the Draft RAWP is planned for submittal in late 2018.

Phase 2 RA for Parcel E

The Phase 2 RA for Parcel E, which focuses on IR-03, will consist of the following activities:

- Treat mobile NAPL at IR-03 via ISS
- Construct a slurry wall surrounding nonmobile NAPL and related groundwater contamination at IR-03

- Remove and dispose of contaminated material (that contains NAPL and soil with elevated concentrations of TPH) on the bay-side of the slurry wall at IR-03
- Construct shoreline protection features at IR-03

The Phase 2 RAWP for Parcel E was started in 2017, and the draft RAWP is expected to be published in September 2018.

Phase 3 RA for Parcel E

The Phase 3 RA for Parcel E will consist of the following activities:

- Remove and dispose of contaminated soil in Tier 1, Tier 2, and TPH locations within (or adjacent to) the proposed shoreline protection
- Construct a slurry wall along the shoreline at IR-02 Northwest
- Construct shoreline protection features at the rest of Parcel E (outside of IR-03)

The Phase 3 RAWP for Parcel E was started in 2018 but was not completed at the time the fourth five-year review was published. The remaining RA phases will include final radiological remediation and surveys and construction of durable covers in the upland areas of Parcel E.

Future RA Work

Future RA activities will include the following activities:

- Perform radiological surveys and remediation in structures, former building sites, and buried storm drain and sewer lines (located outside of IR-02 and IR-03) that were not completed during previous TCRA
- Implement corrective actions to ensure that previous radiological surveys and remediation (completed during the TCRA) are compliant with the RAOs
- Perform radiological surveys and remediation throughout IR-02 and IR-03 that include (1) scanning the entire area for radioactivity to a depth of at least 1 foot; (2) separating and disposing of materials and soil with radiological contamination found during the surveys; and (3) constructing a 2-foot-thick soil cover that includes a demarcation layer to mark the boundary between the existing surface and the soil cover
- Construct durable covers (consisting of either asphalt or soil) throughout Parcel E to prevent exposure to remaining contaminants in soil (the soil cover at IR-03 and the northwest portion of IR-02 would also include a protective liner to minimize water seeping into contaminated soil)
- All radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs. Section 6.1.6 further discusses the review of radiological work (including the conditions prompting the review), and Section 7 discusses how the review will be used to ensure the radiological remedies remain protective.

ICs, consisting of land use and activity restrictions that will be incorporated into deeds and CRUPs at the time of transfer, are currently being developed for Parcel E to prevent exposure to areas where potential unacceptable risk is posed by COCs in soil, soil gas, and groundwater and by radionuclides in soil. The LUC RD for Parcel E addresses the ICs required by the ROD (CES, 2018b). The IC performance objectives will be met by access restrictions until Parcel E is transferred out of Navy ownership.

3.3.6.2. LTM and Maintenance Activities

The LTM and maintenance program will be detailed in the post-construction O&M Plan for Parcel E and will be implemented following completion of all RA construction activities. Groundwater monitoring is the only monitoring activity currently performed in Parcel E, as described below.

Groundwater at Parcel E is currently monitored in support of the selected remedy as specified in the ROD (Navy, 2013e), with monitoring recommendations provided in the Final FS Report (ERRG, 2012b). The Navy is currently developing a RAMP for Parcel E, which will define the LTM requirements and, when finalized, be incorporated into the BGMP.

For Parcel E, the COCs were identified as metals, VOCs, and TPH (Navy, 2013e). The ROD also lists some metals, PCBs, and pesticides as chemicals of potential ecological concern (COPECs). Additionally, groundwater samples are analyzed for radionuclides at Parcel E to demonstrate that they are not present in groundwater at activity levels that are both statistically significant and pose an unacceptable risk to human health and the environment.

Groundwater monitoring is currently conducted throughout HPNS under the BGMP (CE2-Kleinfelder JV, 2011b and 2012c; Trevet, Inc., 2017a). The BGMP includes periodic monitoring of groundwater elevations to evaluate the direction and gradient of groundwater flow and sampling and analysis of COCs at varying frequencies. Periodic monitoring reports are published that describe the monitoring results.

At Parcel E, the BGMP includes collection of groundwater samples from 27 wells for analysis of COCs, including metals, VOCs, SVOCs, pesticides, PCBs, TPH, MNA parameters (including dissolved gasses, total organic carbon, anions, and alkalinity), silica, and radionuclides (including cesium-137, radium-226, and strontium-90). Currently, groundwater elevation measurements are collected at 68 wells at Parcel E-2 wells on a regular basis using data-logging pressure transducers (Trevet, Inc., 2017a). Metals (copper, nickel, and zinc), naphthalene, TCE, VC, and total TPH historically exceed their respective TLs and RGs in various monitoring wells at Parcel E.

Annual monitoring will continue at Parcel E until the RAMP is finalized, at which point the LTM requirements will be incorporated into the BGMP.

3.3.7. Parcel E-2

3.3.7.1. RA Activities and Implementation of ICs

The RD for Parcel E-2 was started in 2012 and included two pre-design investigations, the last of which was completed in 2013. The Navy published the Final RD Package, which describes the basis of design for the final remedy, in August 2014 (ERRG, 2014f). The remedy components for each contaminated medium are described below.

- **Soil and Shoreline Sediment:** The selected remedy for soil and shoreline sediment consists of (1) removal and disposal of contaminated soil and sediment in selected areas that contain nonradioactive chemicals (including metals, SVOCs, PCBs, and TPH) at concentrations exceeding risk-based levels, as well as separation and disposal of materials and soil with radiological contamination found in these areas; (2) radiological surveys followed by separation and disposal of radiologically contaminated materials and soil; (3) construction of a durable cover consisting of a 2-foot soil cover and a protective liner (comprising a geomembrane with an overlying geocomposite drainage layer) over upland areas; (4) construction of a durable cover consisting of a 4-foot soil cover over wetland areas; (5) construction of a durable cover consisting of riprap revetment along shoreline areas; and (6) ICs to restrict specific land uses and activities.
- **Landfill Gas:** The selected remedy for landfill gas consists of (1) removal and treatment of landfill gas to prevent it from moving beyond the Parcel E-2 boundary, (2) monitoring of landfill gas concentrations to track the effectiveness of the landfill gas treatment system, and (3) ICs to restrict specific land uses and activities.
- **Groundwater:** The selected remedy for groundwater consists of (1) construction of below-ground barriers to limit migration of groundwater contaminants from the landfill to San Francisco Bay, (2) MNA, and (3) ICs to restrict specific land uses and activities.

Figure 9 identifies the locations of major remedy components at Parcel E-2. The RA at Parcel E-2 is being implemented in phases. At the time this report was prepared, the first phase of the RA had been completed, the second phase of the RA was being implemented, and the RAWP for the third (and final) phase of the RA was being prepared. The following paragraphs briefly describe the three phases of the RA.

Phase 1 RA for Parcel E-2

The Phase 1 RA for Parcel E-2 consisted of the following activities:

- Remove and dispose of contaminated soil and sediment in hotspot areas
- Install a slurry wall along the Parcel E-2 shoreline (referred to as the "nearshore slurry wall")

The Phase 1 RA for Parcel E-2 was initiated in 2014 and was completed in 2017 (Gilbane Federal, 2018d). Approximately 39,004 bank cubic yards of contaminated soil was excavated, screened, and removed from the hotspot areas. In addition, approximately 5,324 bank cubic yards of soil and debris was excavated prior to installation of the nearshore slurry wall, and another 3,499 bank cubic yards of material was trenched during installation of the slurry wall. In total, 49 10-cubic-yard roll-off bins of LLRW were generated

during the project, and 99 radioactive commodities were recovered and removed. Approximately 1,237 linear feet of nearshore slurry wall was installed to prevent groundwater located bayward of the landfill waste from contacting surface water in San Francisco Bay.

Phase 2 RA for Parcel E-2

The Phase 2 RA for Parcel E-2 consists of the following activities:

- Excavate soil, shoreline sediment, and solid waste and consolidate it on site
- Perform radiological surveys throughout Parcel E-2 and separate and dispose of materials and soil with radiological contamination found during the surveys
- Install foundation layer for soil cover over all of Parcel E-2
- Install shoreline revetment
- Install slurry wall along the western boundary of Parcel E-2 (referred to as the "upland slurry wall")

The Phase 2 RA for Parcel E-2 was initiated in 2016 and is scheduled for completion in early 2019.

Phase 3 RA for Parcel E-2

The Phase 3 RA for Parcel E-2 will consist of the following activities:

- Install a soil cover over all of Parcel E-2, with a protective liner
- Install landfill gas extraction and treatment system
- Construct surface water controls, including new tidal and freshwater wetlands (that are being constructed to offset the loss of wetlands at Parcel E-2 and other areas at HPNS)
- Install cover vegetation

The Phase 3 RAWP was submitted in December 2018 (KEMRON Environmental Services, Inc., 2018), and RA construction will start in 2019.

3.3.7.2. LTM and Maintenance Activities

The LTM and maintenance program will be detailed in the post-construction O&M Plan for Parcel E-2 and will be implemented following completion of all RA construction activities. Monitoring activities are currently conducted on an interim basis for several components of the remedy and include monitoring of methane gas, inspection and maintenance of the interim landfill cap, and monitoring of stormwater discharge. Additionally, groundwater monitoring is performed as part of the BGMP.

Methane Gas Monitoring

Landfill gas is monitored on a monthly basis under the Interim Landfill Gas Monitoring and Control Plan (MCP) (ITSI and Tetra Tech EM Inc. [TtEMI], 2004). The purpose of landfill gas monitoring is to verify

the gas collection and control system is preventing landfill gas from migrating beyond the Parcel E-2 boundary and is effectively reducing emissions of methane and nonmethane organic compounds (NMOCs) in accordance with the RAOs. Monitoring results between 2013 and 2018 indicated that all methane and NMOC concentrations were less than their corresponding action levels, except for a methane exceedance at one monitoring location during March 2015 (CKY, Inc., 2014a, 2014b, 2014c, 2014e, 2014f, 2015a, 2015b, 2015c, 2015d, 2015e, 2015f, 2015g, 2015j, 2016a, 2016b, 2016c, 2016d, 2016e, 2016f, 2016g, 2016i, 2016j, 2016k, 2016l, 2017a, 2017b, 2017c, 2017d, 2017e, 2017e, 2017f, 2017h, 2017i, 2018a, and 2018b). In response to the March 2015 exceedance, active gas extraction was conducted for approximately 1 week and, in accordance with the MCP, ceased after two consecutive monitoring events demonstrated that methane concentrations were less than the action level (2.5 percent methane by volume). The current landfill gas control system will be replaced by the landfill gas extraction and treatment system to be constructed during Phase 3 of the RA.

Landfill Cap Inspection and Maintenance

Inspection and maintenance of the interim landfill cap is conducted in accordance with a site-specific O&M Plan (TtEMI, 2003b). The plan describes the procedures necessary to ensure the integrity of the interim landfill cap. The plan also includes emergency response procedures, which are to be followed in the event of a flood, major storm event, earthquake, or fire (TtEMI, 2003). O&M procedures associated with the closed landfill include (1) irrigating the landfill cap to maintain the vegetative cover and (2) mowing the vegetative cover on and adjacent to the cap to reduce potential fire hazards and prevent the growth of large shrubs and trees whose root structure could penetrate the cap. General site inspections are performed quarterly to assess the condition of vegetation growth on the cap, verify that no erosion or settlement of the soil cover has occurred, assess the presence of burrowing animals in the soil cover, and ensure that all components of the cap are functioning properly. Vegetative cover inspections are performed semiannually to ensure that vegetation growing on the interim cap is sufficient to prevent soil erosion without damaging the underlying geosynthetic membrane, and to assess the need for mowing vegetation on and adjacent to the cap. Maintenance activities performed during this five-year review period include mowing the vegetative cover twice per year and routinely filling animal burrows. Results of the O&M inspections (CKY, Inc., 2014d, 2015i, 2016h, and 2017g) confirm that the interim landfill cap is being properly maintained in accordance with the O&M Plan. O&M of the interim landfill cap was suspended in 2017, when Phase 2 RA construction began in the area. The Phase 2 RAWP for Parcel E-2 (CB&I Federal Services LLC, 2016b) identifies procedures to be followed during construction to maintain the integrity of the interim landfill cap (which will be integrated into the final cover system to be constructed during the Phase 3 RA).

Stormwater Discharge Monitoring

Compared with the flat-lying terrain at most other HPNS areas, Parcel E-2 has more vertical relief—ranging in elevation from about 30 feet above msl to sea level at the shoreline. Consequently, there is an increased potential for erosion and sediment transport by flowing stormwater. During implementation of the Phase 1 and Phase 2 RA activities completed at Parcel E-2 to date, stormwater monitoring and management has

been performed in accordance with the RAWPs (ITSI Gilbane Company, 2014a; CB&I Federal Services LLC, 2016b). Following completion of the RA, stormwater monitoring at Parcel E-2 will be performed in accordance with the RAMP (ERRG, 2014f).

Groundwater Monitoring

The RAOs for groundwater at Parcel E-2 were established based on COCs and COECs, potential receptors and exposure scenarios, and human health and ecological risk (Navy, 2012). In Parcel E-2, the COCs in groundwater are metals (including hexavalent chromium), VOCs, SVOCs, pesticides, PCBs, and TPH. Due to potential hazards from some analytes to aquatic life in San Francisco Bay, un-ionized ammonia, cyanide, sulfide, copper, lead, zinc, total PCBs, and total TPH have been added to the sampling program as COPECs and are monitored to verify the protectiveness of the remedy (Navy, 2012). The ROD states that groundwater does not appear to have been impacted by radionuclides at activity levels that warrant RA. However, since Parcel E-2 required an RA for other COCs, groundwater monitoring includes analysis of radionuclides to verify the conclusions of the radiological addendum (Navy, 2012).

Groundwater monitoring is conducted throughout HPNS under the BGMP (CE2-Kleinfelder JV, 2011b and 2012c; Trevet, Inc., 2017a). The BGMP includes collection of groundwater samples from 17 wells for analysis of metals, VOCs, SVOCs, pesticides, PCBs, TPH, ammonia, cyanide, and radionuclides (including cesium-137, radium-226, and strontium-90). Of the 17 wells, 16 wells are sampled semiannually and 1 well is sampled biennially. Metals, VOCs, and total TPH consistently exceed their respective TLs and RGs in various monitoring wells in Parcel E-2.

Currently, groundwater elevation measurements are collected on a regular basis at 24 wells at Parcel E-2 using data-logging pressure transducers (Trevet, 2017a). The BGMP includes periodic monitoring of groundwater elevations to evaluate the direction and gradient of groundwater flow and sampling for various COCs at varying frequencies. Periodic monitoring reports are published that describe the monitoring results and compare the results to the RGs to verify the RAOs for groundwater are being met.

Current monitoring of these wells will continue in accordance with the RAMP (ERRG, 2014f) and subsequent modifications made under the BGMP.

3.3.8. Parcel F

A ROD for Parcel F has not yet been published, but is expected to be completed in 2019. Post-ROD RA and LTM and maintenance activities will be discussed and evaluated in future five-year review reports.

3.3.9. Parcel G

3.3.9.1. RA Activities and Implementation of ICs

The Navy published the Final RD Package for Parcel G, which describes the basis of design for the final remedy, in October 2010 (ChaduxTt, 2010c). The Final RD package was revised in January 2011 to include

an updated LUC RD (ChaduxTt, 2011b). The remedy components for each contaminated medium are described below.

- **Soil and Soil Gas:** The selected remedy for soil and soil gas consists of (1) excavation of soil hot spots and removal of soil stockpiles where COC concentrations exceed RGs; (2) construction of a durable cover consisting of a minimum 2-inch-thick existing asphaltic concrete pavement restored by installation of an asphalt seal coat or asphaltic concrete overlay (in areas with repairable existing pavement); (3) construction of a durable cover consisting of 2 inches of asphaltic concrete placed over new or existing aggregate base course (in areas with heavily degraded existing pavement); (4) restoration of cracks and penetrations in building foundations; (5) soil gas surveys to evaluate vapor intrusion risks and assess the need for additional remedial activities or ARICs; and (6) ICs to restrict specific land uses and activities.
- **Groundwater:** The selected remedy for groundwater consists of (1) treatment of VOCs in groundwater at IR-09, IR-33, and IR-71 through ISB or ZVI; (2) minimizing the migration of metals in groundwater into San Francisco Bay, (3) MNA for remaining VOCs and metals in groundwater, and (4) ICs to restrict specific land uses and activities.
- **Radiologically Impacted Media:** The selected remedy for radiologically impacted media consists of (1) decontamination or dismantling and offsite disposal of radiologically impacted structures; (2) excavation and offsite disposal of radiologically impacted storm drain and sanitary sewer lines and soil from adjacent impacted areas; and (3) surveys to obtain unrestricted release of buildings, former building sites, and radiologically impacted areas.

Figure 10 identifies the locations of major remedy components at Parcel G. Completion of the RA activities in Parcel G occurred in phases. Several of the soil stockpiles at Parcel G were removed as part of initial removal actions or RA activities that were conducted in the vicinity of the stockpiles. An RA to remove soil hot spots and the remaining stockpiles was conducted between August 2010 and May 2011 (ERRG, 2011). A soil gas study was completed in 2013 (SES, 2013); results from the study were used to evaluate potential risk to human health via vapor intrusion and to assess the need for ARICs for VOC vapors. Construction of the durable covers was performed between January 2013 and July 2013 (ARCADIS U.S., Inc. [ARCADIS], 2014a).

The pre-ROD groundwater treatability study included an assessment of the risks posed to human health and the environment from metals and VOCs in five separate groundwater plumes within Parcels D-1 and G (Alliance, 2010). Three of these plumes (known as the IR-09 North, IR-09 South, and IR-33 plumes) are present entirely within Parcel G, and two of the plumes (known as the IR-71 West and IR71 East plumes) are present in both Parcels D-1 and G. The treatability study concluded that two plumes required treatment with ZVI to address VOCs in groundwater, including TCE at the IR-09 North plume and chloroform at the IR-71 West plume. The risk assessment completed during the treatability study demonstrated that the other plumes (including the IR-33 plume) did not require treatment to address metals or VOCs in groundwater. To treat the two VOC plumes, approximately 148,000 pounds of ZVI was injected into 97 groundwater injection points in IR-09 and IR-71 between October and December 2008, prior to the publication of the ROD. A post-injection groundwater and soil vapor assessment was conducted between December 2008

and April 2009 to verify the effectiveness of the ZVI treatment (Alliance, 2010). A pickling vault located at IR-09 was removed in 2010 to address elevated concentrations of chromium VI in groundwater, and approximately 31,000 pounds of ZVI was placed in the excavation following the removal (TtEC, 2010a). Based on the treatability study risk assessment results, concentrations of metals in groundwater do not pose a potential risk to future construction workers at Parcel G and do not exceed criteria for protection of ecological receptors in San Francisco Bay (Alliance, 2010). Post-ROD groundwater monitoring for VOCs and metals is currently ongoing under the BGMP (see Section 3.3.9.2).

In total, approximately 66 loose cubic yards of soil was excavated from two hotspot areas in Parcel G to address lead and PAH contamination. The excavated soil was disposed of off site, and the excavations were backfilled with clean imported soil (ERRG, 2011). Two soil stockpiles identified in the RD, totaling 20 cubic yards, were also removed and disposed of off site (ERRG, 2011).

An asphalt cover was constructed over all exterior (non-building) portions of Parcel G. The asphalt cover consists of a combination of restored areas of the existing asphalt pavement (in areas where the existing asphalt pavement was repairable) and newly installed asphalt pavement (in areas where the existing asphalt pavement was heavily degraded). The existing asphalt was restored, when possible, by either applying an asphalt seal coat or installing a 2-inch asphaltic concrete overlay. New asphalt pavement, consisting of 2 inches of asphaltic concrete overlying an aggregate base course, was installed over the portions of Parcel G where the historical pavement layer was not present at or near the ground surface. Drainage features such as swales, diversion berms, catch basins, and storm drain pipes were incorporated into the asphalt cover to convey stormwater off site (ARCADIS, 2014a).

Concrete building foundations and concrete pads were restored by filling cracks and penetrations with non-shrink grout to prevent access to the underlying soil (ARCADIS, 2014a).

Radiological remediation at Parcel G began in 2007 (under a basewide TCRA [Navy, 2006]) and was completed in 2011 as part of the RA. In total, 50,688 cubic yards of soil was removed from 23,166 linear feet of sanitary sewer and storm drain lines; approximately 2,828 cubic yards of soil was disposed of off site as LLRW. Nine radiologically impacted buildings (351, 351A, 364, 365, 366, 401, 408, 411, and 439) and one former building site (317/364/365) were screened and remediated (TtEC, 2011b). All radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs. Section 6.1.6 further discusses the review of radiological work (including the conditions prompting the review), and Section 7 discusses how the review will be used to ensure the radiological remedies remain protective.

Land use and activity restrictions were designed to limit exposure of future landowners or users of the property to hazardous substances and to maintain the integrity of the remedy. The land use and activity restrictions will be met by controlling access to the property until the time of transfer. The land use and

activity restrictions described in the LUC RD Report (ChaduxTt, 2011b) will be incorporated into the Quitclaim Deed and CRUP and will take effect upon transfer to the OCII and issuance of those documents.

3.3.9.2. LTM and Maintenance Activities

Long-term maintenance requirements are described in the O&M Plan for Parcel G (ARCADIS, 2014b) and a letter amendment to the O&M Plan (Navy, 2015b). The O&M Plan includes inspection items that are similar to those described for Parcels B-1 and B-2 (see Section 3.3.2.2).

Durable Cover Maintenance and IC Compliance

Quarterly inspections were conducted in October 2013, February 2014, July 2014, and November 2014 during the first year of the post-RA O&M period (ARCADIS, 2015). The Navy did not conduct formal inspections of Parcel G in 2015 (i.e., the second year of long-term monitoring and maintenance); however, the Navy did perform informal inspections and maintenance to ensure the integrity of the remedy components. An annual inspection was conducted in June 2016 during the third year of O&M (ARCADIS, 2016) and an annual inspection was conducted in October 2017 during the fourth year of O&M (IEJV, 2018a). In 2017, O&M activities were realigned to match those described for IR-07/18 in Section 3.3.1.2.

Throughout the first 4 years of LTM and maintenance, inspections generally concluded that the remedies remain intact and in good condition and they are functioning as intended. Minor issues encountered included several small areas of damage to the asphalt cover due to weed growth through the cover, ponded water accumulating in high-traffic areas, and isolated areas of cover settlement due to contractor activities. The damaged asphalt cover was repaired in each area by removing weeds (if present), preparing the subgrade, and installing asphalt or concrete patches to restore the cover. A drainage pipe was installed in the area where the asphalt cover was damaged by excessive ponding to prevent future damage due to ponding. All items were addressed in a timely manner and in accordance with the O&M Plan (ARCADIS, 2014b).

In 2014, 2015, and 2017, the Navy conducted inspections to verify compliance with the ICs applicable to Parcel G. The inspection reports certify that the ICs are being implemented in accordance with the LUC RD (ChaduxTt, 2011b).

Groundwater Monitoring

For Parcel G, the COCs in groundwater are metals and VOCs. The list of specific metals and VOCs is presented in the ROD (Navy, 2009b). Groundwater monitoring is conducted throughout HPNS under the BGMP (CE2-Kleinfelder JV, 2011b and 2012b; Trevet, Inc., 2017a). The BGMP includes periodic monitoring of groundwater elevations to evaluate the direction and gradient of groundwater flow and sampling and analysis of COCs at varying frequencies. Periodic monitoring reports are published that describe the monitoring results and compare the results to the RGs to verify that the RAOs for groundwater are being met.

At Parcel G, the BGMP includes collection of groundwater samples from four wells for analysis of VOCs (with three wells sampled semiannually and one well sampled biennially). Carbon tetrachloride, chloroform, and PCE have historically exceeded their respective RGs in Parcel G groundwater, but recent concentrations (from March 2018) indicate decreasing concentration trends (Trevet, Inc., 2018c). In 2012, monitoring of chromium VI was discontinued from the BGMP because the concentrations were an order of magnitude less than the TL and were stable or decreasing (CE2-Kleinfelder JV, 2012b). Appendix D presents a figure depicting select groundwater data (for COCs exceeding the RGs at Parcel G) from the first quarter 2018 sampling event.

The Navy conducted an investigation in August 2017 to evaluate whether PFAS are present in groundwater at IR-09 within Parcel G as a result of historical uses (Trevet, Inc., 2018b). IR-09 was one of two sites at HPNS (along with IR-10 in Parcel B-1; see Section 3.3.2.2) with past uses (i.e., metal finishing) that indicated the potential for PFAS to be present in groundwater. At IR-09, monitoring wells IR09MW61A, IR09MW62A, and IR09MW31A1 were analyzed for PFAS compounds, including PFOA, PFOS, combined PFOA and PFOS, PFBS, and an additional 11 PFAS compounds by EPA Method 537 Modified. PFOA was detected in two monitoring wells (IR09MW61A and IR09P040A) at concentrations less than the FSC of 70 ng/L. PFOS was detected in all three monitoring wells at concentrations less than the FSC of 70 ng/L. Combined PFOA and PFOS were detected in two monitoring wells (IR09MW62A and IR09P040A) at concentrations less than the FSC of 70 ng/L. PFBS was detected in two monitoring wells (IR09P040A and IR09MW61A) at concentrations significantly less than the FSC of 380 ng/L during the PFAS groundwater investigation. Concentrations of PFOA, PFOS, combined PFOA and PFOS, and PFBS were less than their respective FSCs during the PFAS groundwater investigation. Based on available data, groundwater at IR-09 has not been affected by PFAS.

Between 2013 and 2016, the BGMP at Parcel G included quarterly measurements of groundwater elevation at 20 wells. Since 2017, groundwater elevation measurements have been collected on a regular basis at 20 wells at Parcel G using data-logging pressure transducers (Trevet, 2017a).

Current monitoring of the Parcel G wells will continue in accordance with the RAMP (ChaduxTt, 2011b) and subsequent modifications made under the BGMP.

3.3.10. Parcels UC-1 and UC-2

3.3.10.1. RA Activities and Implementation of ICs

The Navy published the Final RD Package for Parcels UC-1 and UC-2, which describes the basis of design for the final remedy, in December 2010 (ChaduxTt, 2010e). The remedy components for each contaminated medium are described below.

- **Soil and Soil Gas:** The selected remedy for soil, sediment, and soil gas consists of (1) construction of a durable cover consisting of a 2-foot soil cover over vegetated slopes in Parcel UC-2; (2) construction of a durable cover consisting of new or repaired asphaltic concrete

for roadways in Parcels UC-1 and UC-2; (3) conducting soil gas surveys to evaluate potential vapor intrusion risks and assess the extents of the ARICs for VOC vapors; and (4) ICs to restrict specific land uses and activities.

- **Groundwater:** The selected remedy for groundwater consists of (1) MNA for VOCs in groundwater in Parcel UC-2 and (2) ICs to restrict specific land uses and activities.
- **Radiologically Impacted Media:** The selected remedy for radiologically impacted media consists of (1) decontamination or dismantling and offsite disposal of radiologically impacted structures; (2) excavation and offsite disposal of radiologically impacted storm drain and sanitary sewer lines and soil from adjacent impacted areas; and (3) survey and obtain unrestricted release of buildings, former building sites, and radiologically impacted areas.

Figures 11 and 12 identify the locations of major remedy components at Parcels UC-1 and UC-2. The RAs for Parcels UC-1 and UC-2 were implemented concurrently. Construction of the remedies in Parcels UC-1 and UC-2 began in May 2012 and were completed in September 2012 (ERRG, 2013c). The RA included removal of the top 2 feet of soil from the sloped areas above Fisher and Spear Avenues and replacement with clean imported soil to serve as a durable cover. The soil cover was stabilized with hand-planted native species. The RA also included repair and replacement of damaged portions of the roadways, sidewalks, and gutters along Fisher and Spear Avenues to establish a contiguous durable cover over hardscape areas. Drainage features were also constructed to improve the conveyance of stormwater off site. Groundwater monitoring wells at Parcel UC-2 were incorporated into the cover construction, and drainage features were included in the construction to convey storm water off site. Soil gas studies were completed in 2013 and 2014 (SES, 2013; ERRG, 2014g); results from the studies were used to evaluate potential risks to human health via vapor intrusion and to assess the need for ARICs for VOC vapors.

Radiological removals began in 2004 (under a basewide TCRA), and continued and were completed as part of the RA. In total, 20,680 cubic yards of soil was removed from 6,407 linear feet of sanitary sewer and storm drain lines; approximately 876 cubic yards of soil was disposed of off site as LLRW (TtEC, 2011a). One radiologically impacted building (819) at Parcel UC-1 was screened and remediated (TtEC, 2011a). All radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs. Section 6.1.6 further discusses the review of radiological work (including the conditions prompting the review), and Section 7 discusses how the review will be used to ensure the radiological remedies remain protective.

3.3.10.2. LTM and Maintenance Activities

Durable Cover Maintenance and IC Compliance

Long-term maintenance requirements are detailed in the O&M Plan for Parcels UC-1 and UC-2 (ERRG, 2013d). The O&M Plan includes inspection items that are similar to those described for Parcels B-1 and B-2 (see Section 3.3.2.2).

The Navy conducted quarterly inspections and maintenance events for remedies in Parcels UC-1 and UC-2 in January, April, July, and October 2013 (ERRG, 2014a). The inspection frequency was reduced to

semiannually following the first year of LTM and maintenance. Inspections and maintenance were performed semiannually in April and October 2014 during the second year of LTM and maintenance (ERRG, 2015e). Only a single semiannual inspection and maintenance event was performed in April 2015, because the property was transferred to the OCII before the scheduled second semiannual event (ERRG, 2015e). The OCII's developer performed inspection and maintenance events in Parcels UC-1 and UC-2 in 2016 and 2017 (Geosyntec-Albion Joint Association, 2017 and 2018) in accordance with the Risk Management Plan for Parcels UC-1 and UC-2 (Geosyntec Consultants, 2015). Inspections and maintenance were temporarily suspended in 2018 due to redevelopment construction activities. The Navy anticipates that it will receive documentation on restoration of the covers (which was already performed) in conjunction with the 2018 annual inspection and maintenance report.

Throughout the first 3 years of LTM and maintenance, inspections generally concluded that the remedies remain intact and in good condition and they are functioning as intended. Minor issues encountered included minor damage to the asphalt cover due to heavy truck traffic, contractor activities, and weed growth, and minor areas of poor vegetation growth due to drought. Repairs made during the quarterly inspections during the first 3 years of long-term monitoring included minor maintenance items such as revegetation of poor growth areas, weed removal in sidewalk seams, and minor asphalt repairs (ERRG 2014a, 2015e, and 2015l; Geosyntec-Albion Joint Association, 2017 and 2018). Each of these items was addressed in a timely manner and in accordance with the O&M Plan (ERRG, 2013d).

In 2013, 2014, and 2015, the Navy conducted inspections to verify continued compliance with the ICs applicable to Parcels UC-1 and UC-2. The inspection reports certify that the ICs are being implemented in accordance with the LUC RD (ChaduxTt, 2010e). Parcels UC-1 and UC-2 were transferred out of federal ownership to the OCII in late 2015. The OCII has assumed responsibility for maintaining the durable cover remedies, performing the IC inspections, and submitting annual O&M reports to the FFA signatories. During preparation of this five-year review, the durable covers in Parcels UC-1 and UC-2 were observed to be severely damaged due to redevelopment construction activities that, as discussed in Section 5.3., were performed in accordance with an approved Risk Management Plan (Geosyntec Consultants, 2015). A subsequent inspection verified that the covers have since been restored. The OCII and its developer will continue to maintain the durable covers.

Groundwater Monitoring

No groundwater monitoring wells are at Parcel UC-1; consequently, no groundwater monitoring is conducted at Parcel UC-1 under the BGMP. For Parcel UC-2, the COCs in groundwater are chloroform and carbon tetrachloride (Navy, 2009d). This property has been transferred to the OCII; however, the Navy continues to monitor groundwater under its BGMP (CE2-Kleinfelder JV, 2011b and 2012c; Trevet, Inc., 2017a). The BGMP includes quarterly monitoring of groundwater elevations to evaluate the direction and gradient of groundwater flow and sampling and analysis for COCs at varying frequencies.

Periodic monitoring reports are published that describe the monitoring results and compare the results to the RGs to verify the RAOs for groundwater are being met.

The ROD for Parcel UC-2 identified natural attenuation as the remedy for VOCs in groundwater (Navy, 2009d). Groundwater samples are collected from one monitoring well (IR06MW56F) at Parcel UC-2 for analysis of VOCs (carbon tetrachloride and chloroform) and MNA parameters. Carbon tetrachloride and chloroform have not been reported at this well since regular monitoring was started in 2011 (Trevet, Inc., 2018c). Additionally, a soil vapor investigation conducted in 2010 did not identify any risk to human health from inhalation via vapor intrusion in the area of the identified groundwater plume. Historically, no COCs exceeded RGs in groundwater.

3.3.11. Parcel UC-3

3.3.11.1. RA Activities and Implementation of ICs

The Navy published the Final RD for Parcel UC-3, which describes the basis of design for the components of the final remedy, in early 2016 (Amec Foster Wheeler Environment & Infrastructure, Inc. [Amec Foster Wheeler], 2016a). The remedy components for each contaminated medium are described below.

- **Soil and Soil Gas:** The selected remedy for soil and soil gas consists of (1) excavation and offsite disposal of soil contaminated by metals, SVOCs, and TPH from selected areas along the railroad right-of-way (IR-52); (2) construction of a durable cover consisting of asphalt and concrete surfaces corresponding to Redevelopment Block MU-3 on the eastern portion of Parcel UC-3; (3) steam line sampling and either removal or clean and closure in place (IR-45) within Parcel UC-3; (4) soil gas survey at the IR-56 plume area and at soil areas impacted by selected SVOCs and TPH to evaluate the effectiveness of excavation remedies; (5) parcel-wide soil gas survey to determine the reduction or retention of the designated ARIC; and (6) ICs to restrict specific land uses and activities.
- **Groundwater:** The selected remedy for groundwater consists of treatment of groundwater VOCs by injection of an organic compound, MNA, and ICs.
- **Radiologically Impacted Media:** The remedy for radiologically impacted media consists of excavation and offsite disposal of radiologically impacted sewer and storm drain lines.

Figure 13 identifies the locations of major remedy components at Parcel UC-3. RA activities in Parcel UC-3 began in October 2016 and were are substantially completed in November 2017. The activities completed under the RA included hotspot excavation, installation of durable cover, and a soil gas survey. These activities are documented in the RACR (Gilbane Federal, 2018e).

In total, 783 cubic yards of contaminated soil was excavated from three hotspot areas in Parcel UC-3 to address metals (copper and lead), SVOCs, and TPH. In total, approximately 1,200 tons of soil was transported and disposed of at an offsite facility during the Parcel UC-3 RA.

Approximately 47,000 square feet of pavement was repaired, and another 47,000 square feet of new pavement was installed in Parcel UC-3. New pavement consisted of 4 inches of aggregate base course overlain by 4 inches of asphaltic concrete. Existing infiltration trenches, which capture and remove surface water from the surrounding paved areas, were integrated into the durable cover.

The active soil gas survey involved collection of soil gas samples from three soil gas monitoring probes installed as part of the RA. The results of the survey revealed that residual benzene contamination in soil near groundwater well IR74MW01A is generating soil gas that exceeds the designated soil gas action level. Accordingly, the Navy plans to retain an ARIC related to VOC vapors in this area to address future inhalation and other exposure hazards.

The steam line closure component of the selected soil remedy was not performed as part of the RA because the portion of the steam line within Parcel UC-3 was not used for conveying oil, it was assessed during previous site investigations with no evidence of contamination, and it is outside of the area where previous investigations had identified waste oil impacts in the steam lines (Amec Foster Wheeler, 2016a).

The groundwater remedy was not implemented as part of the RA because historical and current TCE concentrations in groundwater at the IR-56 plume have not exceeded the RG since monitoring began in 1996 and have not exceeded the vapor intrusion criterion since the end of 2009 (Amec Foster Wheeler, 2016a).

Radiological removals were started in 2009 and completed in 2011, under a basewide TCRA and prior to the issuance of the ROD. In total, 18,024 cubic yards of soil was removed from 18,363 linear feet of sanitary sewer and storm drain lines; approximately 789 cubic yards of soil was disposed of off site as LLRW (TtEC, 2012b). All radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs. Section 6.1.6 further discusses the review of radiological work (including the conditions prompting the review), and Section 7 discusses how the review will be used to ensure the radiological remedies remain protective.

3.3.11.2. LTM and Maintenance Activities

Durable Cover Maintenance and IC Compliance

Long-term maintenance requirements are detailed in the O&M Plan for Parcel UC-3 (Gilbane Federal, 2018f). The O&M Plan includes inspection items that are similar to those described for Parcels B-1 and B-2 (see Section 3.3.2.2).

Prior to finalizing the O&M Plan for Parcel UC-3 in July 2018, inspection and maintenance of the durable covers were performed as part of the RA construction activities that were documented in the RACR (Gilbane Federal, 2018e). The Navy conducted post-RA inspections in August and September 2018 (Gilbane Federal, 2018f), and future O&M activities will be aligned to match those described for IR-07/18 in Section 3.3.1.2.

Throughout the first year of LTM and maintenance, inspections generally concluded that the remedies remain intact and in good condition and they are functioning as intended. During the August and September 2018 inspections, extensive cracking was observed in areas where existing pavement was repaired during the RA (Gilbane Federal, 2018g). Repair activities are being coordinated with other construction activities in Parcel UC-3, and are expected to be completed by early 2019.

Groundwater Monitoring

The Navy monitored groundwater at Parcel UC-3 under its BGMP (CE2-Kleinfelder JV, 2011b and 2012c; Trevet, Inc., 2017a). Groundwater has been monitored quarterly for TCE and chloroform at the only well (IR74MW01A) at IR-56 within Parcel UC-3. Historically, no COCs have exceeded their RGs in this monitoring well. The groundwater monitoring RAOs have been met in Parcel UC-3, so groundwater monitoring activities associated with the parcel have ceased (Trevet, Inc., 2018a).

Section 4. Progress Since Last Review

This section provides protectiveness statements and associated recommendations presented in the Third Five-Year Review. This section also discusses the progress made toward addressing those recommendations. The Third Five-Year Review Report did not evaluate Parcels E and UC-3 because the RODs were not complete at the time the report was finalized in November 2013. The Third Five-Year Review Report did not provide a protectiveness statement for Parcel E-2 because the RA activities had not begun. Accordingly, this section focuses only on those areas (i.e., IR-07/18 and Parcels B-1, B-2, C, D-1, D-2, G, UC-1, and UC-2) where RODs were completed and the RA had been initiated at the time the report was finalized in November 2013.

4.1. IR-07/18

The Third Five-Year Review Report included the following protectiveness statement for IR-07/18 (TriEco-Tt, 2013b):

> *"The remedy for the portion of Parcel B at Sites IR-07 and IR-18 is protective of human health and the environment.*
>
> *Previous soil removals and durable covers on upland areas and the revetment along the shoreline have achieved the RAO of preventing exposure to contaminants, including radionuclides, in soil and sediment. Removal of the methane source has achieved the RAO for methane. Data collected during ongoing groundwater monitoring along the bay margin do not indicate migration of COCs at levels that would pose a risk to human health or the environment. The IC performance objectives specified in the amended ROD are being met by access controls until the time of transfer to prevent potential exposure. The effective implementation of IC performance objectives through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer will effectively prevent exposure to COCs and prevent activities that could damage the integrity of the remedy following transfer of the property."*

The Third Five-Year Review Report did not present any issues or recommendations for IR-07/18 (TriEco-Tt, 2013b). Accordingly, the Third Five-Year Review Report did not prompt any follow-up actions at IR-07/18.

4.2. PARCELS B-1 AND B-2

The Third Five-Year Review Report included the following protectiveness statement for the remainder of Parcel B (excluding IR-07/18), which was subdivided (in 2013) into Parcels B-1 and B-2 (TriEco-Tt, 2013b):

> *"The remedy for the remainder of Parcel B is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.*
>
> *The excavation and off-site disposal of soil was completed in 2010. Likewise, the radiologically related portions of the remedy have been completed, and DTSC approved an unrestricted release for radionuclides in the remainder of Parcel B (that is, excluding Sites IR-07 and IR-18). Construction of the remaining components of the remedy, including covers and revetment, operation of the SVE system at IR-10, and treatment of groundwater at IR-10 are under way. During construction, potential risk posed by exposure to contaminants in soil, soil vapor, or groundwater is controlled by access restrictions. The effective implementation of IC performance objectives through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer will effectively prevent exposure to COCs and prevent activities that could damage the integrity of the remedy following transfer of the property."*

The Third Five-Year Review Report identified an issue regarding mercury concentrations in groundwater within Parcel B-2 (at IR-26 wells IR26MW49A and IR26MW51A). Mercury concentrations continue to exceed the trigger level despite previous soil removal actions. The Third Five-Year Review Report recommended that (1) groundwater at wells IR26MW49A and IR26MW51A should continue to be monitored semiannually for mercury to evaluate the trend in mercury concentrations, and (2) the mass flux of mercury into the bay in the vicinity of wells IR26MW49A and IR26MW51A should be evaluated (TriEco-Tt, 2013b).

Since 2013, groundwater continues to be monitored for mercury at bay margin wells (including wells IR26MW49A and IR26MW51A) under the BGMP. A dissolved mercury mass discharge evaluation was conducted at IR-26 in 2015 to estimate the mass discharge of mercury to San Francisco bay via groundwater transport (TriEco-Tt, 2016). Based on the results of that evaluation, the Navy is implementing in-situ stabilization of mercury to minimize migration of mercury in groundwater to the bay, as described in Section 3.3.2. The stabilization effort is currently underway and its performance will be reported in a future RACR.

4.3. PARCEL C

The Third Five-Year Review Report included the following protectiveness statement for Parcel C (TriEco-Tt, 2013b):

> *"The remedy for Parcel C is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.*
>
> *Soil excavation, groundwater treatment using lactate injection and SVE are underway. Radiological removals are also underway. Construction of the remaining components of the remedy (durable covers) will proceed after the radiological removals and excavations have been completed. During construction, potential risk posed by exposure to contaminants in soil, soil vapor, or groundwater is controlled by access restrictions. The effective implementation of IC performance objectives through land use and activity*

> *restrictions incorporated into deeds and CRUPs at the time of transfer will effectively prevent exposure to COCs and prevent activities that could damage the integrity of the remedy following transfer of the property."*

The Third Five-Year Review Report did not present any issues or recommendations for Parcel C (TriEco-Tt, 2013b). Accordingly, the Third Five-Year Review Report did not prompt any follow-up actions at Parcel C.

4.4. PARCEL D-1

The Third Five-Year Review Report included the following protectiveness statement for Parcel D-1 (TriEco-Tt, 2013b):

> *"The remedy for Parcel D-1 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.*
>
> *The excavation and off-site disposal of soil was partially completed in 2010. Groundwater treatment using ZVI injection was completed in 2008. Radiological removals are under way. Construction of the remaining components of the remedy (removal of two remaining areas and covers) will proceed after the radiological removals have been completed. During construction, potential risk posed by exposure to contaminants in soil, soil vapor, or groundwater is controlled by access restrictions. The effective implementation of IC performance objectives through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer will effectively prevent exposure to COCs and prevent activities that could damage the integrity of the remedy following transfer of the property."*

The Third Five-Year Review Report did not present any issues or recommendations for Parcel D-1 (TriEco-Tt, 2013b). Accordingly, the Third Five-Year Review Report did not prompt any follow-up actions at Parcel D-1.

4.5. PARCEL D-2

The Third Five-Year Review Report did not include a protectiveness statement for Parcel D-2, because the parcel was deemed to require no further action following completion of radiological remediation.

4.6. PARCEL G

The Third Five-Year Review Report included the following protectiveness statement for Parcel G (TriEco-Tt, 2013b):

> *"The remedy for Parcel G is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.*
>
> *The excavation and off-site disposal of soil and removal of soil stockpiles were completed in 2010. Groundwater treatment using ZVI injection was completed at IR-09 and IR-71 in 2008. The radiologically related portions of the remedy have been completed, and DTSC*

> *approved an unrestricted release for radionuclides in Parcel G. Construction of the remaining component of the remedy (covers) is substantially completed. During construction, potential risk posed by exposure to contaminants in soil, soil vapor, or groundwater is controlled by access restrictions. The effective implementation of IC performance objectives through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer will effectively prevent exposure to COCs and prevent activities that could damage the integrity of the remedy following transfer of the property."*

The Third Five-Year Review Report did not present any issues or recommendations for Parcel G (TriEco-Tt, 2013b). Accordingly, the Third Five-Year Review Report did not prompt any follow-up actions at Parcel G.

4.7. PARCEL UC-1

The Third Five-Year Review Report included the following protectiveness statement for Parcel UC-1 (TriEco-Tt, 2013b):

> *"The remedy for Parcel UC-1 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.*
>
> *Previous soil removals and durable covers have achieved the RAO of preventing exposure to contaminants in soil. The radiologically related portions of the remedy have been completed, and DTSC approved an unrestricted release for radionuclides in Parcel UC-1. Plans for a soil vapor survey at Parcel UC-1 are in progress. The IC performance objectives specified in the ROD are being met by access controls until the time of transfer to prevent potential exposure. The effective implementation of IC performance objectives through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer will effectively prevent exposure to COCs and prevent activities that could damage the integrity of the remedy following transfer of the property."*

The Third Five-Year Review Report did not present any issues or recommendations for Parcel UC-1 (TriEco-Tt, 2013b). Accordingly, the Third Five-Year Review Report did not prompt any follow-up actions at Parcel UC-1.

4.8. PARCEL UC-2

The Third Five-Year Review Report included the following protectiveness statement for Parcel UC-2 (TriEco-Tt, 2013b):

> *"The remedy for Parcel UC-2 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.*
>
> *Previous soil removals and durable covers have achieved the RAO of preventing exposure to contaminants in soil. The radiologically related portions of the remedy have been completed, and DTSC approved an unrestricted release for radionuclides in Parcel UC-2.*

> *Concentrations of VOCs in groundwater are less than remediation goals or are decreasing. During monitoring of natural attenuation, potential risk posed by exposure to contaminants in soil, soil vapor, or groundwater is controlled by access restrictions. The effective implementation of IC performance objectives through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer will effectively prevent exposure to COCs and prevent activities that could damage the integrity of the remedy following transfer of the property."*

The Third Five-Year Review Report did not present any issues or recommendations for Parcel UC-2 (TriEco-Tt, 2013b). Accordingly, the Third Five-Year Review Report did not prompt any follow-up actions at Parcel UC-2.

Section 5. Five-Year Review Process

This section describes activities conducted in support of this Fourth Five-Year Review Report for HPNS.

5.1. COMMUNITY NOTIFICATION, INVOLVEMENT, AND SITE INTERVIEWS

Members of the BRAC Cleanup Team (BCT) were notified of the initiation of the five-year review process at a meeting held on March 8, 2018. The members of the BCT were also interviewed to solicit their feedback for this report and they were requested to review and comment on the draft version of this report.

Members of the San Francisco community were notified about the initiation of five-year review process through an email sent on April 1, 2018; at a community meeting held on April 11, 2018; and through public notices published in local newspapers (*San Francisco Chronicle* and *San Francisco Bay View*) in June 2018. The public notices informed the community members that the Fourth Five-Year Review Report would be made available for public review and comment.

BCT members (which include EPA, DTSC, and the Water Board) and San Francisco Department of Public Health representatives were interviewed on February 22, 2018, as part of the five-year review process. Appendix B contains records of the interviews. The most common issues and concerns raised during the interviews are summarized below.

- Concerns related to the adequacy of historical radiological remediation based on the discovery of falsification of radiological data by a Navy contractor. The radiological issues have resulted in (1) distrust of the Navy's cleanup program by the regulatory agencies and the community; (2) delays in the achievement of cleanup, transfer, and redevelopment of the affected parcels; and (3) increased workloads for regulatory agency representatives, resulting in delays in document reviews.
- Community expectations that the regulatory agencies more actively oversee future Navy work and be involved with developing the plans to address the radiological remediation issues to ensure that work is performed appropriately.
- The need for the Navy to increase its community involvement effort and ensure the transparent exchange of information with the public.
- The need for increased communication by the Navy at BCT meetings in advance of planning and executing work to avoid general confusion and time spent by the regulatory agencies reviewing documents, commenting on documents, and understanding the scopes and intent of the work.
- Concerns about Navy document quality and responsiveness to comments on documents leading to lengthy regulatory agency reviews and extensive comments.
- Dust generation and control during cleanup work activities.

Additionally, local community members were invited to participate in a survey on February 26, 2018, regarding the status of cleanup activities conducted over the past 5 years. Appendix B contains records of the survey responses. The most common issues and concerns raised in the surveys are summarized below.

- General lack of public trust in the adequacy of the cleanup work and how information on the radiological issues has been communicated.
- Concerns over losses in property value caused by the discovery of the radiological cleanup issues, the effect of delays in redevelopment on the community's growth and value, and whether it is safe to live in Parcel A.
- The need for the Navy to act quickly to address the radiological cleanup issues and communicate progress with the community more frequently, transparently, and effectively.
- Dust generation during cleanup work activities.

Appendix B also includes correspondence received from several community stakeholders following the public review of the draft Fourth Five-Year Review Report. The most common concern raised during the public review related to the protectiveness determination for the radiological remedies. Specifically, several reviewers questioned how the radiological remedies could be considered "protective" in light of the questions regarding the validity of the radiological data. Sections 6 and 7 accurately state that the radiological data identified in reports associated with Parcels B-1, B-2, C, D-2, E, G, UC-1, UC-2, and UC-3 were deemed unreliable, and corrective actions are required to ensure the radiological remedies specified in the RODs are implemented as intended. Sections 6 and 7 additionally describe how the Navy is evaluating the radiological RGs to ensure the remedies will be protective in the long term, with human health risk falling within the risk range as described in the NCP.

In response to these comments, the protectiveness statements in Section 8 were revised to better address the status of the radiological remediation and ensure consistency with EPA (2012a) guidance.

5.2. DOCUMENT AND DATA REVIEW

As part of this five-year review, documents and data related to remedy implementation were reviewed for each parcel. The reviews primarily focused on (1) documents and data that provide information on the technical and regulatory considerations that led to remedy selection and implementation, (2) documents that demonstrate remedy completion, and (3) documents and parcel-specific data that demonstrate the remedies continue to be protective of human health and the environment.

The types of documents reviewed include those focused on remedy implementation, maintenance, and monitoring, such as RDs, LUC RDs, RAMPs, RAWPs, RACRs, O&M Plans, post-construction O&M reports, soil vapor investigation reports, SVE progress reports, groundwater treatment progress reports, and BGMP reports, including semiannual groundwater monitoring reports.

The types of data reviewed to assess remedy performance include:

- Soil confirmation sampling data collected following hotspot excavation remedies
- Soil gas data collected during soil gas investigations
- Qualitative remedy performance data presented in O&M inspection reports
- SVE data collected as part of SVE remedy monitoring
- Groundwater treatment data collected to evaluate performance of in-situ groundwater treatment remedies
- Groundwater data for metals and VOCs collected as part of MNA and LTM remedies

The Navy has completed an extensive review of the radiological remediation documents and data as part of its evaluation of the potential contractor manipulation and/or falsification of data and has identified the areas (within Parcels B-1, B-2, C, D-2, E, G, UC-1, UC-2, and UC-3) where resurveying for radionuclides is required to address all issues discovered during the Navy's evaluation. Any available information on the status of the review and discoveries made by the Navy were considered during the development of this five-year review. Section 6.1.6 details the Navy's findings regarding the radiological surveys and remediation.

5.3. SITE INSPECTIONS

The Navy conducted site inspections for this review on January 29, 2018. The purpose of the site inspections was to review and document current site conditions to assist in evaluating the protectiveness of the remedial systems. Site access and general site conditions were also evaluated during the inspection. Appendix C contains the site inspection checklists and associated photographic logs that document the observations made during the inspections.

The inspection focused on the completed cover remedies at IR-07/18 and Parcels B-1, B-2, C, G, and UC-3. At the time of the inspections, the completed cover remedies in Parcels UC-1 and UC-2, which have already been transferred to the OCII, were in disrepair due to redevelopment construction activities that are being performed in accordance with an approved Risk Management Plan (Geosyntec Consultants, 2015). In accordance with the LUC RD (ChaduxTt, 2010e), implementation of the procedures in a Risk Management Plan (that is approved by the FFA signatories) allows for construction activities to be performed in a manner that remains protective of human health and the environment. The roadways in Parcels UC-1 and UC-2 were damaged as a result of heavy truck traffic associated with construction within the new Hunters Point Artist Parcel. As a result, these covers could not be inspected in January 2018; however, a subsequent inspection verified that the covers have since been restored. These observations indicate that the durable cover remedies at all sites are operating properly and successfully.

The soil cover at IR-07/18 was observed to be in good condition with no evidence of settlement, erosion, bulges, or cracks. All slopes appeared stable, and the cover vegetation was well established. Minor holes (typically 2 to 5 inches in diameter) that did not appear to extend far below surface were observed. The holes would not endanger the effectiveness of the soil cover, which is at least 3 feet thick within the radiological ARIC and at least 2 feet thick in other areas. The shoreline revetment was observed to be in good condition, with some sand refilling the bayward areas of the revetment toe. The small asphalt cover at the northeastern corner of IR-07 was observed to be in good condition. As described in Section 3.3.1.2,

the Navy performs regular inspections of the durable cover at IR-07/18, and noted deficiencies are addressed in a timely manner and in accordance with the O&M Plan (ERRG, 2012d). Appendix C also contains site inspection checklists and associated photographic logs from the annual O&M inspection (conducted in October 2018) that document the adequacy of the cover system at IR-07/18.

The soil cover in Parcel B-1 was observed to be in good condition with no evidence of settlement, erosion, bulges, or cracks. All slopes appeared stable, and the cover vegetation was well established. The asphalt cover and building foundations across Parcels B-1 and B-2 were observed to be in good condition, with only minor damage caused by weed growth at seams in the asphalt cover. Swales were intact and free of major debris. The shoreline revetment was observed to be in good condition. As described in Section 3.3.2.2, the Navy performs regular inspections of the durable covers at Parcels B-1 and B-2, and noted deficiencies are addressed in a timely manner and in accordance with the O&M Plans (ERRG, 2016; IEJV, 2018c). Appendix C also contains site inspection checklists and associated photographic logs from the annual O&M inspection (conducted in October 2018) that document the adequacy of the cover system at Parcels B-1 and B-2.

The asphalt cover and building foundations across Parcels C were observed to be in good condition, with only minor damage caused by weed growth at seams in the asphalt cover. Swales were intact and free of major debris. The shoreline armoring area near the entrance to Dry Dock 2 was observed to be in good condition. As described in Section 3.3.3.2, the Navy performs regular inspections of the durable cover at Parcel C, and noted deficiencies are addressed in a timely manner and in accordance with the O&M Plan (TtEC, 2017b). Appendix C also contains site inspection checklists and associated photographic logs from the annual O&M inspection (conducted in October 2018) that document the adequacy of the cover system at Parcel C.

The asphalt cover and building foundations across Parcel G were observed to be in good condition, with only minor damage caused by weed growth at seams in the asphalt cover. Swales were intact and free of major debris. As described in Section 3.3.9.2, the Navy performs regular inspections of the durable cover at Parcel G, and noted deficiencies are addressed in a timely manner and in accordance with the O&M Plan (ARCADIS, 2014b). Appendix C also contains site inspection checklists and associated photographic logs from the annual O&M inspection (conducted in October 2018) that document the adequacy of the cover system at Parcel G.

The newly installed asphalt cover in Parcel UC-3 was observed to be in good condition, with some damage caused by frequent traffic on the roadway surface. The infiltration trenches in the roadway shoulder were intact and free of major debris. As described in Section 3.3.11.2, the Navy performed the first post-RA inspection of the durable cover at Parcel UC-3 in August 2018, and noted extensive cracking in areas where existing pavement was repaired during the RA. Repair activities are being coordinated with other construction activities in Parcel UC-3, and are expected to be completed by early 2019.

Monitoring well surface completions observed during the site inspections were found to be in good condition. The interior of each monitoring well is regularly inspected during the semiannual groundwater sampling events, and includes inspection of the condition of well casings, lids, locking caps, and labels.

Any damage that affects the integrity of the monitoring well is repaired in a timely manner. Semiannual groundwater monitoring reports summarize the condition of the monitoring wells and describe maintenance actions (as appropriate). Based on a review of the most recent semiannual groundwater monitoring reports, the interior of each well was generally observed to be in good condition.

Section 6. Technical Assessment

Three questions are examined in the technical assessment to evaluate whether the completed remedies at HPNS are protective of human health and the environment:

- Question A: Is the remedy functioning as intended by the decision documents?
- Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid?
- Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

The following sections address each of these questions, based on the information and data summaries presented in previous sections. The discussion presented in the following sections provides a framework for the protectiveness statements that are provided in Section 8. The technical assessments and protectiveness statements relate to remedies that have been implemented and demonstrated to be complete at the time of this five-year review.

6.1. QUESTION A

Is the remedy functioning as intended by the decision documents?

Each type of remedy implemented to date was evaluated to determine whether it is functioning as designed. The factors listed below were considered when making the determination about each remedy:

RA performance (if applicable):

- Whether the RA continues to operate and function as designed
- Whether cleanup levels are being achieved or are on a path to be achieved in a reasonable time frame
- Whether containment is effective, if applicable
- Whether opportunities exist to improve the performance and/or reduce costs of monitoring, sampling, and treatment systems

System O&M (if applicable):

- Whether operating procedures, as implemented, are working in a manner that will continue to maintain the effectiveness of the remedy
- Whether frequent equipment breakdowns or changes indicate a potential issue affecting protectiveness
- Whether large variances in O&M costs could indicate a potential remedy problem

Implementation of ICs and other measures (if applicable):

- Whether ICs are in place and are proving to be effective in preventing exposure
- Whether access controls (e.g., fencing and warning signs) are in place and are proving to be effective in preventing exposure
- Whether other actions (e.g., removals) necessary to ensure that immediate threats have been addressed are complete

The responses to Question A are discussed below for each remedy component, most of which have been implemented at multiple parcels. Only remedy components that have been implemented and demonstrated to be complete are evaluated in this technical assessment.

6.1.1. Excavation and Offsite Disposal of Soil Hot Spots

Are the hotspot excavation remedies implemented in Parcels B-1, B-2, C, D-1, E-2, G, and UC-3 functioning as intended by the decision documents? YES

RA Performance: Published documents verify that the hotspot excavations, as required by the RODs, were implemented properly and are reducing site-wide risk as intended in Parcels B-1, B-2, C, D-1, E-2, G, and UC-3. The hotspot excavations included the collection of confirmation samples to demonstrate adequate removal of soil. All hot spots were backfilled with clean imported soil meeting specified backfill acceptance criteria. Permanent removal of soil that poses an unacceptable exposure risk, in combination with the durable cover remedies described in Section 6.1.2, effectively achieves the RAO of preventing exposure to organic and inorganic chemicals in soil at concentrations greater than RGs. No opportunities for optimization or early indicators of potential problems were identified for the hotspot excavations during this review.

System O&M: Not applicable.

Implementation of ICs and other measures: Section 6.1.2 discusses implementation of the ICs to addresses exposure to remaining contaminants in soil and sediment.

6.1.2. Durable Covers

Are the durable cover remedies implemented in IR-07/18 and Parcels B-1, B-2, C, D-1, G, UC-1, UC-2, and UC-3 functioning as intended by the decision documents? YES

RA Performance: Published documents, site inspections, and communication with personnel knowledgeable about the sites indicate that the durable covers, as required by the RODs, were implemented properly and are functioning as intended in IR-07/18 and Parcels B-1, B-2, C, D-1, G, UC-1, UC-2, and UC-3. Durable covers on upland areas and along the shoreline have been shown to effectively contain and prevent exposure to remaining organic and inorganic chemicals in soil and sediment. The proper function of the durable covers effectively achieves the RAO of preventing exposure to organic and inorganic chemicals in soil at concentrations greater than the RGs. In Parcels UC-1 and UC-2, where durable covers have been compromised by redevelopment work, construction activities are being implemented and monitored in accordance with an approved Risk Management Plan that complies with applicable ICs. No opportunities for optimization or early indicators of potential problems were identified for the durable covers during this review.

System O&M: The durable covers in IR-07/18 and Parcels B-1, B-2, C, D-1, G, UC-1, UC-2, and UC-3 are monitored and maintained in accordance with their respective O&M Plans. Regularly scheduled inspections performed by qualified professionals have verified that all durable covers within the post-construction O&M phase are in good condition, and that O&M of the covers has been effective. Minor issues encountered, such as asphalt cover damaged by weed growth or heavy traffic, animal burrows in soil covers, areas of poor vegetation growth on soil covers, and breaches of the perimeter fence, have not compromised the integrity of the remedy. O&M costs are generally consistent from year to year and are not anticipated to change significantly as long as the current configurations of the durable cover remedies are maintained. In Parcels UC-1 and UC-2, where durable covers were observed to be damaged by redevelopment work, construction activities were implemented and monitored in accordance with an approved Risk Management Plan (Geosyntec Consultants, 2015) and included restoration of the durable covers. In Parcel UC-3, the Navy performed the first post-RA inspection of the durable cover in August 2018, and noted extensive cracking in areas where existing pavement was repaired during the RA; repair activities are being coordinated with other construction activities and are expected to be completed by early 2019.

Implementation of ICs and Other Measures: The IC performance objectives specified in the RODs for IR-07/18 and Parcels B-1, B-2, C, D-1, G, and UC-3 are being met by access restrictions (that will remain in place until the time of transfer) to prevent potential exposure to hazardous substances in soil and sediment. Overall access to HPNS is restricted by manned, restricted-access checkpoints. Access to most sites and parcels is additionally controlled by fencing and signs at the site. Access controls will not be required in the future following the completion of redevelopment activities. The effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will effectively limit exposure of property users to hazardous substances following transfer of the property.

At Parcels UC-1 and UC-2, which were transferred to the OCII in late 2015, redevelopment construction activities are implemented and monitored in accordance with an approved Risk Management Plan (Geosyntec Consultants, 2015).

The Navy and the OCII perform annual inspections to verify compliance with the ICs designated by each site's or parcel's LUC RD. The inspection reports certify that the ICs are being implemented in accordance with the LUC RDs.

6.1.3. SVE

Are the SVE remedies implemented in Parcels B-1 and C functioning as intended by the decision documents? YES. The source of the VOC mass in the vadose zone is being reduced by SVE. However, mass removal efficiency is low due to mass diffusion limitations in the heterogeneous soil at HPNS.

RA Performance: SVE remedies are currently being implemented in Parcel B-1 (IR-10) and seven of eight planned treatment areas (1, 3, 4, 5, 6, 7, and 8) in Parcel C. Treatment in Area 2 is pending implementation of other RA activities to address soil and groundwater contamination. The goal of implementing SVE in Parcels B-1 and C is to reduce the source of the VOC mass in soil. The SVE technology was prescribed for use in Parcels B-1 and C as long as operations are efficient (i.e., mass removal is cost effective).

The SVE systems installed and activated to date in Parcels B-1 and C were constructed and operated in accordance with the RODs, RDs, and system-specific operation and optimization plans.

System O&M: SVE system operation in Parcels B-1 and C is ongoing. Operations are monitored and optimized, as required, to maximize removal efficiency. Optimization measures include system modifications to improve operational performance, pulsed and cycled operation of extraction wells, targeted operation of SVE wells in the areas of highest contaminant concentrations, optimization of vacuum pressures to control radii of influence and minimize water entrainment from the SVE wells, and passive air venting to address stagnation points. The mass removal achieved to date is summarized below.

- Approximately 21.7 pounds of VOCs (predominantly TCE) has been removed from IR-10 in Parcel B-1.
- Approximately 3.2 pounds of VOCs (predominantly TCE) has been removed to date from Area 1 in Parcel C.
- Approximately 1.7 pounds of VOCs (predominantly PCE and TCE) has been removed to date from Areas 3, 4, and 5 in Parcel C.
- Approximately 4.2 pounds of VOCs (predominantly TCE) has been removed to date from Areas 6 and 7 in Parcel C.
- Approximately 22 pounds of VOCs (predominantly PCE and TCE) has been removed to date from Area 8 in Parcel C.

Despite proper system operation and optimization, SVE treatment has achieved a limited reduction in the contaminant source to date in all active treatment areas within Parcels B-1 and C. SVE operations have revealed the systems are operating in diffusion-limited conditions, which reduces the efficiency of mass removal and results in long rebound times. SVE operations in Parcels B-1 and C are characterized by rapid declines in soil gas concentrations upon initiation of SVE system operations, followed by long rebound/equilibration periods where soil gas ultimately approaches initial concentrations, indicating that transport of the VOC mass from soil to soil gas is limited by a slow rate of diffusion. Soil at HPNS is primarily artificial fill composed of low-permeability heterogeneous silts and clays with gravel and debris. The slow transport rate of VOC mass from low-permeability soil has limited the VOC mass removed to date.

This review has determined that SVE, although being implemented in accordance with the RODs and RDs and meeting the ROD objective of removing VOCs, is not operating efficiently to reduce the mass of source contamination in soil. Optimization of the existing SVE systems will not significantly improve source mass reduction.

Implementation of ICs and Other Measures: The IC performance objectives specified in the RODs are being met by access restrictions (that will remain in place until the time of transfer) to prevent potential exposure to soil gas. Construction of enclosed structures will be restricted and may require implementation of engineering controls and monitoring. The effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will effectively prevent exposure of property users to hazardous substances following transfer of the property.

The Navy performs annual inspections to verify compliance with the ICs designated by each parcel's LUC RD. The inspection reports certify that the ICs are being implemented in accordance with the LUC RDs.

6.1.4. In-Situ Groundwater Treatment

Are the in-situ groundwater remedies implemented in Parcels B-1 and C functioning as intended by the decision documents? YES

RA Performance: In-situ groundwater treatment remedies have been implemented in Parcel B-1 (IR-10), Parcel C (RU-C1, RU-C4, and RU-C5), and Parcel G (IR-09 and IR-71). Published documents indicate that the in-situ groundwater treatment remedies, as required by the RODs, were implemented properly. Additional treatment is planned for RU-C1, RU-C2, RU-C4, and RU-C5 in Parcel C in the near future. No opportunities for optimization or early indicators of potential problems were identified for the in-situ groundwater treatment remedies during this review.

System O&M: Performance monitoring of the groundwater treatment remedies is currently being performed under the BGMP and will continue to occur until the RAOs are met at each plume. Monitoring and reporting costs are generally consistent from year to year and are not anticipated to change significantly.

Implementation of ICs and Other Measures: The IC performance objectives specified in the RODs are being met by access restrictions (that will remain in place until the time of transfer) to prevent potential exposure to groundwater. Well installation and groundwater use are restricted. The effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will effectively limit exposure of property users to hazardous substances following transfer of the property.

The Navy performs annual inspections to verify compliance with the ICs designated by each parcel's LUC RD. The inspection reports certify that the ICs are being implemented in accordance with the LUC RDs.

6.1.5. MNA and LTM of Groundwater

Are the MNA and LTM remedies in IR-07/18 and Parcels B-1, B-2, C, D-1, G, UC-2, and UC-3 functioning as intended by the decision documents? YES

RA Performance: MNA of VOC and/or LTM of metals in groundwater are currently being implemented at IR-07/18 and Parcels B-1, B-2, C, D-1, G, and UC-2. MNA for VOCs in groundwater at Parcel UC-3 was specified in the RD, but pre-RA monitoring data demonstrated that groundwater treatment and MNA were unnecessary at Parcel UC-3.

Published documents indicate that the MNA and LTM remedies are being implemented appropriately and in accordance with the RODs and RAMPs. The MNA and LTM remedies are functioning as intended. Data collected during ongoing groundwater monitoring are providing information on the attenuation rates of COCs in groundwater and allowing for data comparisons to RGs and well-specific TLs. Monitoring data collected to date have not identified any concentrations trends that warrant additional action to ensure protection of human and ecological receptors. However, as described in Section 6.1.4, performance monitoring of previous groundwater treatment at Parcels B-1 and C is ongoing and additional treatment is planned in Parcel C. Also, performance monitoring at IR-26 (Parcel B-2) is ongoing to track mercury concentrations in groundwater following recent treatment using in-situ stabilization.

MNA and LTM are implemented under the BGMP. The program is reviewed and optimized regularly. No opportunities for further optimization or early indicators of potential problems were identified for the MNA and LTM remedies during this review.

System O&M: MNA and LTM remedies are currently performed under the BGMP and will continue to occur until the groundwater RGs are met. Monitoring and reporting costs are generally consistent from year to year and are not anticipated to change significantly.

Implementation of ICs and Other Measures: The IC performance objectives specified in the RODs for IR-07/18 and Parcels B-1, B-2, C, G, and UC-3 are being met by access restrictions (that will remain in place until the time of transfer) to prevent potential exposure to groundwater. Well installation and groundwater

use are restricted. The effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will effectively limit exposure of property users to hazardous substances following transfer of the property. At Parcels UC-1 and UC-2, which were transferred to the OCII in late 2015, redevelopment construction activities are implemented and monitored in accordance with an approved Risk Management Plan (Geosyntec Consultants, 2015).

The Navy and the OCII perform annual inspections to verify compliance with the ICs designated by each parcel's LUC RD. The inspection reports certify that the ICs are being implemented in accordance with the LUC RDs.

6.1.6. Radiological Surveys and Remediation

Are the radiological surveys and remediation remedies implemented in IR-07/18 and Parcels B-1, B-2, C, D-1, D-2, E, G, UC-1, UC-2, and UC-3 functioning as intended by the decision documents? YES (for IR-07/18 and Parcel D-1); NO (for Parcels B-1, B-2, C, D-2, E, G, UC-1, UC-2, and UC-3).

RA Performance: Published documents report the completion of radiological surveys and remediation in IR-07/18 and Parcels B-1, B-2, C, D-1, D-2, E, G, UC-1, UC-2, and UC-3. In January 2018, the Navy determined that a significant portion of the radiological survey and remediation work completed to date was not reliable because of manipulation and/or falsification of data by one of its radiological remediation contractors. Radiological data identified in reports associated with Parcels B-1, B-2, C, D-2, E, G, UC-1, UC-2, and UC-3 were deemed unreliable. The Navy is currently in the process of implementing corrective actions (i.e., retesting) to ensure the radiological remedies specified in the RODs are implemented as intended. While the corrective actions are implemented, controls will remain in place to prevent exposure to potential radiological contaminants in structures and soil. Overall access to HPNS is restricted by manned, restricted-access checkpoints. Access to most sites and parcels is additionally controlled by fencing and signs at the site. In addition, access is restricted to structures where radiological remediation is incomplete. Lastly, durable covers (as discussed in Section 6.1.2) are in place and are being maintained to prevent potential exposure to remaining chemicals in soil.

The radiological remedies that have been successfully completed and are functioning as intended are described below.

- In 2010 a MARSSIM Class 1 survey was completed for the entire surface of IR-07/18, and the top 1 foot of soil was remediated to levels specified in the Amended ROD to ensure a radiologically clean surface before the cover remedy was applied. The constructed cover over the portion of IR-07/18 (within the radiological ARIC) prevents exposure to radionuclides in accordance with the RAOs. CDPH completed further surface scans at IR-07/18. CDPH concluded that there was no evidence or indication of radiological health and safety concerns based on surface gamma radiation in the surveyed areas of IR-07/18 (CDPH, 2013). Soil data at this site was not evaluated because residual radiological contamination is assumed to be present in deeper soils, the protective cover was designed to address that residual contamination, and the design and integrity of the final soil cover was verified by CDPH.

Health physicists from the Navy, in consultation with health physicists from the regulatory agencies, will evaluate the additional data collected (during retesting conducted in Parcels B-1, B-2, C, D-2, E, G, UC-1, UC-2, and UC-3) using current guidance to ensure the radiological remedies are protective of human health. The Navy will evaluate if additional work is necessary for Parcel D-1, in consultation with the regulatory agencies.

System O&M: The durable covers within the radiological ARIC in IR-07/18 and throughout Parcel D-1 are monitored and maintained in accordance with the O&M Plans (ERRG, 2012d; APTIM, 2018a). Regularly scheduled inspections performed by qualified professionals have verified that all durable covers within the post-construction O&M phase are in good condition, and that O&M of the covers has been effective. Minor issues encountered, such as animal burrows in soil covers, areas of poor vegetation growth on soil covers, and breaches of the perimeter fence, have not compromised the integrity of the remedy. O&M costs are generally consistent from year to year and are not anticipated to change significantly as long as the current configurations of the durable cover remedies are maintained within the radiological ARIC.

Implementation of ICs and Other Measures: The IC performance objectives that relate to preventing potential exposure to radionuclides within the radiological ARIC in IR-07/18 are being met by access restrictions. The site is currently, and will remain, enclosed by a perimeter fence with locked gates until transfer to the OCII. The durable covers are inspected and maintained in accordance with the O&M Plan (ERRG, 2012d) to prevent contact with underlying soil. The activity and land use restrictions described in the LUC RD Report (ChaduxTt, 2010a) will be incorporated into the Quitclaim Deed and CRUP and will take effect upon transfer to the OCII and issuance of those documents. Future implementation of ICs will effectively limit exposure of property users to hazardous substances following transfer of the property.

ICs for radionuclides are being evaluated for a portion of Parcel D-1. The Navy is planning to amend the existing LUC RD for Parcel D-1 to define those ICs and their area of applicability.

The Navy performs annual inspections to verify compliance with the ICs designated by each parcel's LUC RD. The inspection reports certify that the ICs are being implemented in accordance with the LUC RDs.

6.2. QUESTION B

Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

EPA's guidance document for five-year reviews identifies several areas to be considered in evaluating whether the assumptions made at the time of remedy selection remain valid (EPA, 2001). Areas of consideration include:

Standards and To Be Considered (TBC) Criteria:

- Whether standards identified as ARARs, newly promulgated standards, and/or changes in TBC criteria could call into question the protectiveness of the remedy

Toxicity and Other Contaminant Characteristics:

- Whether toxicity factors for COCs at the site have changed in a way that could affect the protectiveness of the remedy

Risk Assessment Methods:

- Whether risk assessment methodologies or guidance have changed in a way that could affect the protectiveness of the remedy

Exposure Pathways:

- Whether current or reasonably anticipated future land use on or near the site has changed or may change in the near future (including redevelopment or changed resource use)
- Whether human health or ecological routes of exposure or receptors have been newly identified or changed in a way that could affect the protectiveness of the remedy
- Whether there are newly identified contaminants or contaminant sources leading to a potential/actual pathway not previously addressed by the remedy
- Whether there are unanticipated toxic byproducts or daughter products of the remedy not previously addressed by the decision documents
- Whether physical site conditions or the understanding of these conditions have changed in a way that could affect the protectiveness of the remedy

Expected Progress Toward Meeting RAOs:

- Whether the remedy is progressing as expected toward meeting the RAOs
- Whether new site conditions (e.g., discovery of new contaminants) impact the RAOs and remedy protectiveness

Five-year review guidance (EPA, 2001) indicates that the question of interest in developing the five-year review is not whether changes have occurred but rather whether changes call into question the protectiveness of the cleanup action. The following sections evaluate each of the above considerations.

6.2.1. Changes in Standards and TBC Criteria

The Navy evaluated the ARARs established in the RODs for Parcels B (i.e., IR-07/18 and Parcels B-1 and B-2), C, D-1, D-2, E, E-2, G, UC-1, UC-2, and UC-3. No changes to chemical-specific, location-specific,

or action-specific ARARs established in the RODs were identified that would bear on the protectiveness of the remedies.

6.2.2. Changes in Toxicity and Other Contaminant Characteristics

Soil and Groundwater: The Navy evaluated changes in soil and groundwater toxicity criteria and other contaminant characteristics since the third five-year review to determine if they would affect the protectiveness of the remedies. To perform this evaluation, the Navy focused its evaluation on the COCs that are the primary risk drivers in soil and groundwater at HPNS. The primary COCs driving risk in soil are arsenic, benzo(a)pyrene, and Aroclor-1260, and the primary COCs driving risk in groundwater are TCE, PCE, and VC.

The RGs established in the ROD for the primary risk drivers in soil and groundwater at Parcels B, C, D-1, G, UC-1, UC-2, and UC-3 were selected based on a comparison of the COC-specific risk-based concentration (RBC), the laboratory practical quantitation limit (PQL) based on standard EPA analytical methods, and the Hunters Point ambient level (HPAL) for a broad group of metals. The RBCs were calculated based on a target excess cancer risk level of 1×10^{-6} and target noncancer HI of 1, consistent with the exposure pathways and assumptions used in the parcel-specific HHRAs to assess risks. Table 16 provides the soil RGs identified in the RODs for the primary COCs, and Table 17 provides the groundwater RGs for the primary COCs.

Changes to toxicity criteria have occurred since the signing of the RODs. These changes are observable as differences between the ROD RBCs and current risk-based values developed by EPA and CalEPA DTSC. Current risk-based values were obtained from EPA's Regional Screening Level (RSL) Tables (EPA, 2018) and DTSC's HHRA Note Number 3 (DTSC, 2019). The toxicity values used to calculate RSLs are selected using a hierarchy of toxicological sources, with the Integrated Risk Information System as its primary source. For most chemicals, DTSC endorses the values listed in the EPA RSL tables. However, some values listed in the EPA RSL tables differ significantly from values calculated using CalEPA toxicity criteria and risk assessment procedures. DTSC-modified screening levels (DTSC-SLs) are used in conjunction with the EPA RSLs to evaluate chemical concentrations in environmental media at California sites and facilities. Note that the DTSC-SLs are derived at a target risk level of 1×10^{-6} and a target hazard quotient (HQ) of 1 as are the EPA RSLs. Table 16 shows a comparison of current risk-based values for soil to the RGs listed in the RODs.

For groundwater, risk-based values were based on the groundwater to indoor air exposure pathway (i.e., vapor intrusion). Table 17 shows a comparison of ROD RGs and current EPA Vapor Intrusion Screening Levels (VISLs). The VISLs are based on default residential or nonresidential (i.e., commercial) exposure scenarios, a target cancer risk level of one per million (1×10^{-6}), and a target noncancer HQ of 1.0.

For some of the COCs in soil and groundwater, the RG was based on the laboratory PQL because the RBC was below the PQL at the time of the ROD. However, as analytical techniques improve over time,

laboratories may be able to achieve lower PQLs for some of the COCs. As part of the toxicity evaluation, current analytical limits of quantitation (LOQs) were compared to PQLs listed in the ROD. In present-day terminology, the PQL is referred to as an LOQ in accordance with the DoD Quality Systems Manual for Environmental Laboratories and the Navy's Tier II SAP format guidelines. Furthermore, for analytes where the LOQ is higher than an RBC using the best available technology, another laboratory-specific limit, the detection limit, can be used to evaluate risk and is the preferred laboratory limit for use in risk assessments.

As shown in Tables 16 and 17, the comparison of ROD cleanup levels to current risk-based screening levels and laboratory-specific limits indicate that some levels are higher, some lower, and some levels were nearly the same. Although some changes to the toxicity criteria and to laboratory-specific limits have occurred, these changes do not affect the protectiveness of the remedies because RBC for the primary risk drivers remain within the risk management range. Additionally, protectiveness will be maintained as long as ICs preventing exposure remain in place and ongoing monitoring continues until COC concentrations in soil and groundwater are at such levels to allow for unrestricted use and exposure at the time when the future property owner proposes to terminate those ICs.

Emerging chemicals (PFAS compounds) were added to the analytical suites for groundwater sampling activities in IR-10 (Parcel B-1) and IR-09 (in Parcel G) in August 2017. Concentrations of PFOA, PFOS, combined PFOA and PFOS, and PFBS were less than their respective FSCs during the PFAS groundwater investigation. Based on available data, groundwater at IR-10 and in Parcel G has not been affected with PFAS. As a result, concerns regarding emerging groundwater chemicals do not call into question the protectiveness of the remedies.

No new contaminants or contaminant sources in soil and groundwater originating from the sites have been identified or detected during monitoring performed since the third five-year review. No unanticipated toxic byproducts have been generated as a result of remedy implementation. The toxicity data used at the time of the remedy selection are still valid.

Soil Gas: The Navy is implementing ICs to manage risk associated with soil gas within the ARICs defined for Parcels B-1, B-2, C, D-1, E, G, UC-1, UC-2, and UC-3. In Parcels B-1 and C, the Navy is also implementing active treatment (by SVE and ISB) to reduce the source contamination contributing to elevated COC concentrations in soil gas. The regulatory agencies are currently reviewing and reevaluating their methods for assessing vapor intrusion risk, as discussed further in Section 6.2.3. Those changes may affect the Navy's methodology for developing preliminary soil gas action levels (SGALs) used in post-ROD soil gas investigations to refine the ARICs defined in the RODs. The Navy intends to consider agency concerns and reevaluate its approach to calculating SGALs, which may affect the ARICs for VOC vapors at Parcels B-1, B-2, D-1, and G that were previously adjusted in a 2014 memorandum to the administrative record (Navy, 2014c). Section 6.2.3 further discusses the potential changes to the ARICs for VOC vapors.

Radiologically Impacted Media: The Navy is planning to evaluate the radiological RGs identified in the RODs using current guidance to ensure the long-term protectiveness of the radiological remedies (see further information in Section 7). As part of this evaluation, the Navy will identify any relevant changes in toxicity or other contaminant characteristics that may result in post ROD changes.

6.2.3. Changes in Risk Assessment Methods

Since the RODs were signed and since the third five-year review was completed, EPA issued supplemental guidance updating standard default exposure parameters for use on Superfund sites (EPA, 2014). Standard default updates include the following:

Definition (units)	Previous Value	2014 Value
Resident Skin Surface Area for Soil – Child (cm^2)	2,800	2,373
Resident Skin Surface Area for Soil – Adult (cm^2)	5,700	6,032
Worker Skin Surface Area for Soil – Adult (cm^2)	3,300	3,527
Resident Soil Adherence Factor – Child (mg/cm^2)	0.2	0.2
Resident Soil Adherence Factor – Adult (mg/cm^2)	0.07	0.07
Worker Soil Adherence Factor – Adult (mg/cm^2)	0.2	0.12
Adult Body Weight – Adult (kg)	70	80
Resident Exposure Duration (year)	30	26
Resident Exposure Duration – adult (year)	24	20

Notes:
cm^2 = square centimeters
kg = kilograms
mg/cm^2 = milligrams per square centimeters

Use of these updated default exposure parameters in place of the original values used in the risk assessments for each of the parcels primarily results in increasing the RBCs for the adult receptors. The increase is not significantly different from the values estimated in the original risk assessments. As such, EPA changes to default exposure parameters do not affect the protectiveness of the remedies.

The Navy established preliminary SGALs in 2011, prior to the third five-year review (ChaduxTt, 2011g). The SGALs are "action levels" (not RGs) based on calculated vapor intrusion risks and COCs identified during soil gas assessments conducted in each parcel. The results of comparisons of soil gas concentrations to SGALs supersede the groundwater vapor intrusion risk estimates and COCs identified in the RODs for Parcels B, C, D-1, E, G, UC-1, UC-2, and UC-3. Actions must be taken if results of soil gas surveys exceed SGALs. Those actions may include ICs (e.g., access limitations) or engineering controls (such as a vapor barrier) and would not necessarily prompt additional remediation, as might be implied by the term "remediation goal."

The method used for calculating risk-based concentrations for indoor air is similar to the EPA (2009, 2011a) and CalEPA (2005) methods used to calculate risk-based concentrations for HPNS parcels. A target indoor air cancer risk of 10^{-6} and a noncancer HI of 1 were used for calculating risk-based concentrations for indoor air. These target cancer and noncancer levels are consistent with the levels used to identify COCs in the HHRAs for HPNS. Likewise, the exposure assumptions used to calculate risk-based concentrations for indoor air are consistent with those used in the HHRAs for HPNS.

To translate the risk-based concentrations for indoor air to risk-based concentrations for soil gas, the Navy must make assumptions related to the attenuation and dilution of surface vapors through the vadose zone and building floor slab. The attenuation factors can be based on a model or on empirical data. Currently, the Navy's preliminary SGALs are calculated based on the generic attenuation factors provided in CalEPA (2005) that were derived from the 1991 Johnson and Ettinger model (JEM) (modified to include exposure time and air exchange rate in 2011) and generic attenuation factors provided by EPA (2002) that were derived from empirical data.

The generic attenuation factors presented in CalEPA (2005) were derived from the JEM and are based on the following assumptions: (1) a shallow source of vapors close to the building foundation, (2) relatively permeable (sandy) soil, (3) limited exchange between indoor and outdoor air, (4) homogeneous vapor concentrations underlying the building footprint, (5) constant source concentrations (e.g., no decrease in chemical concentrations over time through biodegradation), (6) under-pressurized buildings, (7) single-story buildings, and (8) lack of lateral vapor transport.

The generic attenuation factors provided in EPA (2002) were derived using empirical data for 40 residences. Shallow soil gas samples are defined as those collected either from directly below the foundation or from depths less than 5 feet below the foundation level. Consequently, EPA identified an attenuation factor of 0.1 as generally reasonable upper-bound value for the case where soil gas is measured directly beneath a foundation (i.e., subslab measurements) or where soil gas is measured at less than 5 feet below the foundation level. Deep soil gas samples (i.e., samples collected from just above the water table or from depths greater than 5 feet below the foundation level) represent a more direct measurement of the source vapor concentration and are subject to less variability than is observed for shallow soil gas samples. Therefore, EPA (2002) recommends an attenuation factor of 0.01 for screening deep soil gas results for residential buildings. EPA (2002) does not specifically provide recommended attenuation factors for nonresidential buildings; however, EPA (2010) recommended an attenuation factor of 0.001 for screening deep soil gas results for industrial buildings at HPNS.

The Navy uses the preliminary SGALs as a first tier screening tool to determine which areas require additional evaluation. Based on the results of the first tier data screening, the Navy may perform a second tier evaluation to refine the SGALs. The second tier evaluation uses modeled, site-specific attenuation factors based on site-specific chemical and geotechnical data. Modeling is performed using the most up-to-date version of JEM at the time of the evaluation.

Since the establishment of the Navy's approach to calculating SGALs, the regulatory agencies (EPA and DTSC) have questioned the validity of using JEM to model active gas sampling and attenuation factors to derive site-specific SGALs. In addition, EPA's previously recommended attenuation factors have changed (EPA, 2015). The EPA has proposed that the Navy cease to implement the second tier evaluations to develop SGALs and exclusively rely upon the results of the first tier evaluations to redefine or reduce ARICs for VOC vapors in the future. The EPA has also proposed that the generic attenuation factor (for screening deep soil gas results for residential buildings) be increased from 0.01 to 0.03, consistent with their 2015 guidance.

The Navy intends to consider agency concerns and reevaluate its approach to calculating SGALs, which may affect the ARICs for VOC vapors at Parcels B-1, B-2, D-1, and G that were previously adjusted in a 2014 memorandum to the administrative record (Navy, 2014c). Appendix E evaluates how EPA's recommendations may affect the SGALs and the ARICs for VOC vapors. Based on the information in Appendix E, none of the potential changes to the ARICs for VOC vapors affect the current protectiveness of the remedies at Parcels B-1, B-2, D-1, and G.

The Navy is planning to evaluate the radiological RGs identified in the RODs using current guidance to ensure the long-term protectiveness of the radiological remedies (see further information in Section 7). As part of this evaluation, the Navy will identify any relevant changes in risk assessment methods that may result in post ROD changes.

6.2.4. Changes in Exposure Pathways

No new routes of exposure that could affect the protectiveness of the remedies have been identified. No changes to site conditions that could result in increased exposure have been identified. No significant changes to the risk assessment methodology have occurred that would affect the protectiveness of the remedy. The vapor intrusion exposure pathway was considered during the risk assessments that were used to support remedy selection.

ICs, including restrictive covenants regulating restricted land use, restricted activities, and prohibited activities, have been implemented to prevent exposure to areas where potential unacceptable risk is posed by COCs in soil and groundwater. ICs will remain in place as long as contamination remains at the site above levels that allow for unlimited use and unrestricted exposure. Physical site conditions or the understanding of these conditions has not changed in a way that could affect the protectiveness of the remedies.

Exposure assumptions developed in the HHRA considered the potential future exposures based on the expected reuses. The HPNS redevelopment plan was updated in 2010 (SFRA 2010). To support implementation of the 2010 redevelopment plan at Parcel G, the OCII prepared a feasibility assessment that analyzed the residual concentrations of non-radiological COCs in soil using health-based regulatory standards to determine whether the residential land use restrictions could be reduced. The feasibility assessment concluded that current site conditions are appropriate for residential use in most of Parcel G. The feasibility assessment also concluded that the areas requiring residential land use restrictions could be reduced (based on

risk levels caused by non-radiological COCs), provided that features of the selected remedy (e.g., durable covers and ICs with an O&M plan) remain in place (Langan, 2016). An ESD to the Final ROD was prepared to document the reduction in the areas requiring residential land use restrictions, based on the recommendations of the feasibility assessment (Navy, 2017). Otherwise, no changes to site conditions or expected reuses that could result in increased exposure have been identified. The exposure assumptions used for the non-radiological COCs at the time of the remedy selection are still valid. In addition, the radiological retesting and an evaluation of radiological RGs (discussed in Section 7) will ensure that the property is suitable for the intended reuse.

6.2.5. Expected Progress Toward Meeting RAOs

The remedies are progressing as expected, except for the SVE remedies in Parcels B-1 and C and radiological remediation in Parcels B-1, B-2, C, D-2, E, G, UC-1, UC-2, and UC-3. Soil removal and containment remedies are functioning as intended to prevent contact with soil and sediment. Groundwater treatment remedies are in progress and being monitored to evaluate their long-term performance. MNA and long-term groundwater monitoring remedies are being implemented to gather the data necessary to track the attenuation of chemicals over time.

SVE remedies currently being implemented in Parcels B-1 and C are minimally effective at reducing the VOC source contamination due to the diffusion limitations inherent to site soil at HPNS. The inefficiency of the SVE technology reduces the long-term effectiveness of the treatment technology. Because the SVE technology is not a cost-effective means of removing VOC contamination from the vadose zone in Parcels B-1 and C in advance of implementation of ICs, use of this technology may be reconsidered. The ICs specified in the RODs, however, remain as an effective remedy for addressing risks from soil vapor intrusion in the future.

The Navy has determined that a significant portion of the radiological survey and remediation work completed to date was not reliable because of manipulation and/or falsification of data by one of its radiological remediation contractors. Radiological data identified in reports associated with Parcels B-1, B-2, C, D-2, E, G, UC-1, UC-2, and UC-3 were deemed unreliable. The Navy is currently in the process of implementing corrective actions (i.e., retesting) to ensure that the radiological remedies specified in the decision documents have been implemented as intended. The radiological rework will successfully achieve the RAOs for radionuclides specified in the RODs. Additionally, the Navy is currently evaluating the radiological RGs to ensure the radiological remedies will be protective in the long term, with human health risk within the risk range as described in the NCP.

6.3. QUESTION C

Has any other information come to light that could call into question the protectiveness of the remedy?
YES.

No new ecological risks have been identified. No weather-related incidents, earthquakes, or other natural disasters have affected the protectiveness of the remedies.

The potential for an increase in the sea level elevation as a result of atmospheric warming (consistent with recent scientific research) has also been considered in the design of the shoreline protection measures at Parcels B-1, B-2, E, E-2 and IR-07, which are needed to control erosion from tidal and wave action from San Francisco Bay. The approved designs accounted for a potential 3-foot increase in sea level when designing the crest elevation for shoreline protection structures. However, the scientific research available at the time the designs were developed has since been updated. The California Ocean Protection Council and the California Natural Resources Agency recently updated statewide guidance for sea-level rise to reflect recent advances in scientific projections (California Ocean Protection Council and California Natural Resources Agency, 2018). Using the methodology of Kopp et al. (2014), the guidance estimated future sea-level rise at the Golden Gate tide gauge in San Francisco. The estimated sea-level rise in San Francisco under three future scenarios (referred to as representative concentration pathways [RCPs]) is summarized below.

- RCP 8.5 is consistent with a future in which there are no significant global efforts to limit or reduce emissions. In 2100, the likely sea-level rise associated with this scenario ranges from 1.6 to 3.4 feet.
- RCP 4.5 is a moderate emissions reduction scenario and assumes that global greenhouse gas emissions will be curtailed. In 2100, the likely sea-level rise associated with this scenario ranges from 1.2 to 2.7 feet.
- RCP 2.6 is a stringent emissions reduction scenario and assumes that global greenhouse gas emissions will be significantly curtailed. In 2100, the likely sea-level rise associated with this scenario ranges from 1.0 to 2.4 feet.

Based on the information summarized above, a contingency of up to a 3-foot increase in sea level provides a reasonable level of protection in designing the crest elevation for the shoreline protection structures at Parcels B-1, B-2, E, E-2, and IR-07. This design contingency is consistent with the approved designs, and no further changes are warranted to ensure protection of human health and the environment. Future five-year reviews should evaluate future sea-level rise (including new information related to the probability of more extreme sea level rise) to verify that the shoreline protection structures can adequately control erosion from tidal and wave action from San Francisco Bay. The shoreline protection structures can be adapted to increase the crest elevation if deemed necessary based on future evaluations. In addition to new information related to the probability of more extreme sea level rise, future evaluations will consider the impact of potential adaptations to the primary design objectives (i.e., to control erosion from tidal and wave action while ensuring the geotechnical stability of the structure and shoreline slope, and integrating the structure with the adjacent upland property).

As discussed in Sections 6.1.6 and 6.2.3, follow-up action is required to ensure radiological remediation and mitigation of vapor intrusion risk are implemented in a manner that is protective. No other information has been identified to suggest that the remedies may not be protective of human health or the environment.

Section 7. Issues, Recommendations, and Other Findings

The tables below presents issues, recommendations, and follow-up actions for HPNS parcels where at least some remedy components have been implemented and demonstrated to be complete. Issues were identified at all HPNS parcels, except for IR-07/18 and Parcel E-2, with complete or partially complete remedies.

<table>
<tr><td rowspan="3">Site(s): Parcels B-1 and C</td><td colspan="4">Issue Category: Other</td></tr>
<tr><td colspan="4">Issue: SVE implementation in Parcels B-1 and C is reducing source mass, but with limited effectiveness due to diffusion-limited conditions in the subsurface. Although ICs will maintain future protectiveness, source removal inefficiency is extending the period within which SVE will be implemented.</td></tr>
<tr><td colspan="4">Recommendation: It is recommended that use of the SVE technology be evaluated for each treatment area due to inefficiency caused by diffusion-limited conditions. Site-specific studies (e.g., remedy analyses) should be performed to estimate the magnitude and extent of source mass at each treatment area in Parcels B-1 and C to determine if other measures could be implemented to enhance SVE performance in the future. Any changes implemented to the approach for reducing source contamination in SVE areas should be discussed in the next five-year review report. Changes made to the treatment approach should be considered for any other SVE treatment areas at HPNS, including areas where treatment is planned but has not yet been initiated.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>No</td><td>Navy</td><td>EPA/DTSC/Water Board</td><td>12/31/2019</td></tr>
</table>

Site(s): Parcels B-1, B-2, D-1, and G	**Issue Category:** Remedy Performance
	Issue: The regulatory agencies do not agree with the Navy's risk assessment methodology used to reduce the ARICs for VOC vapors.
	Recommendation: The Navy intends to consider agency concerns (including specific recommendations made by EPA) and reevaluate its approach to calculating SGALs, which may affect the ARICs for VOC vapors at Parcels B-1, B-2, D-1, and G. Appendix E evaluates how EPA's recommendations may affect the SGALs and the ARICs for VOC vapors. Based on the information in Appendix E, none of the potential changes to the ARICs for VOC vapors affect the current protectiveness of the remedies at Parcels B-1, B-2, D-1, and G. The regulatory agencies are currently reviewing and reevaluating their methods for assessing vapor intrusion risk. Once consensus is achieved, the Navy should reevaluate its approach for calculating SGALs and adjusting ARICs for VOC vapors. The new SGALs would be developed based on the most current standards, toxicity criteria, and risk assessment methods. The new SGALs would be used to redefine the ARICs for soil gas at each parcel prior to property transfer. Any changes to soil gas risk assessment methodology should be discussed in the next five-year review report.

Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	Yes	Navy	EPA/DTSC/Water Board	12/31/2019

Site(s): Parcels B-1, B-2, C, D-1, D-2, E, G, UC-1, UC-2, and UC-3	**Issue Category:** Remedy Performance **Issue:** The Navy has determined that a significant portion of the radiological survey and remediation work completed to date was not reliable because of manipulation and/or falsification of data by one of its radiological contractors. A long-term protectiveness evaluation of the radiological RGs has not yet been completed for this fourth Five-Year Review, and it is currently not known if the RAOs for radionuclides have been achieved in Parcels B-1, B-2, C, D-1, D-2, G, E, UC-1, UC-2, and UC-3. **Recommendation:** The Navy is in the process of implementing corrective actions to ensure that the radiological remedies specified in the decision documents are implemented as intended. In addition, the Navy is in the process of conducting a long-term protectiveness evaluation of the ROD radiological RGs. After finalization of the Five-Year Review, the Navy will issue a draft addendum evaluating the long-term protectiveness of the RGs for soil using RESRAD and the EPA's Preliminary Remediation Goal (PRG) Calculator for radiation risk to human health. Another draft addendum evaluating the long-term protectiveness of the RGs for buildings (for both residential and commercial/industrial scenarios) will also be issued. The draft addenda will include explanations of the proposed site-specific inputs and will be issued to the public and regulatory agencies for a 30-day review and comment period. The Navy will prepare responses to regulatory agency comments and a responsiveness summary to comments from the public. The results of the final evaluations will inform the retesting sensitivity and cleanup thresholds. These risk evaluations may also inform future risk management decisions and the potential for post-ROD changes, if appropriate. It is anticipated that the radiological rework will be completed prior to the next Five-Year Review. Interim Milestone Dates: Draft Addendum for Soil – 1 month after finalization of the Five-Year Review Draft Addendum for Buildings – 2 months after finalization of the Five-Year Review				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**	
No	To Be Determined	Navy	EPA/DTSC/Water Board	11/1/2023	

Section 8. Protectiveness Statement

This section provides the protectiveness statements for each site or parcel where the RA is either currently underway or is demonstrated to be complete. Parcel F is not discussed in this section because, as stated in Section 3.3.8, a ROD for Parcel F has not yet been published.

8.1. IR-07/18

The remedy at IR-07/18 was completed in September 2011 (ERRG, 2012a) and addressed non-radioactive chemicals in soil, sediment, soil gas, and groundwater, as well as radiologically impacted media. Previous soil removals and placement of durable covers on upland areas and along the shoreline have achieved the RAO of preventing exposure to contaminants, including radionuclides, in soil and sediment. Removal of the methane source has achieved the RAO for methane. The durable covers are being maintained in accordance with the O&M Plan (ERRG, 2012d), and access restrictions are in place (and will remain in place until the time of transfer) to limit exposure of property users to hazardous substances.

Groundwater is being monitored in accordance with the RAMP (ChaduxTt, 2010a), and data collected to date have not identified any concentration trends that warrant additional action to ensure protection of human and ecological receptors. The effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will limit exposure of property users to hazardous substances following transfer of the property. This information supports the protectiveness statement provided in the table below.

Site(s): IR-07/18	**Protectiveness Determination:** Protective
Protectiveness Statement: The remedy for IR-07/18 is protective of human health and the environment.	

8.2. PARCEL B-1

The remedy at Parcel B-1 was partially completed in September 2013 (ERRG, 2011 and 2017) and addressed non-radioactive chemicals in soil and sediment, as well as radiologically impacted media. Previous soil removals and placement of durable covers on upland areas and along the shoreline have achieved the RAO of preventing exposure to contaminants in soil and sediment. The durable covers are being maintained in accordance with the O&M Plan (ERRG, 2016), and access restrictions are in place (and will remain in place until the time of transfer) to limit exposure of property users to hazardous substances. Radiological remediation was completed in 2010; however, as described in Section 6.1.6, the supporting data were deemed unreliable and corrective actions are required to ensure the radiological remedy specified in the ROD is implemented as intended.

The remedy to address VOCs in soil gas and groundwater is still being implemented. Performance monitoring following groundwater treatment at IR-10 is being conducted in accordance with the RAMP (ChaduxTt, 2010d) and is expected to demonstrate the remedy is protective of human health. Operation of the SVE system at IR-10 is ongoing but its effectiveness is limited by subsurface conditions. Additional evaluation will be completed by December 2019 to determine if other measures could be implemented to enhance SVE system performance. Upon completion of this portion of the remedy, ICs will be relied upon in the future to limit exposure of property users to VOCs in soil gas and groundwater.

The continued maintenance of the durable cover and the effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will limit exposure of property users to hazardous substances following transfer of the property. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel B-1	**Protectiveness Determination:** Will Be Protective
Protectiveness Statement: The remedy for Parcel B-1 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date (including implementation of access restrictions) have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.	

8.3. PARCEL B-2

The remedy at Parcel B-2 was partially completed in May 2015 (ERRG, 2011 and IEJV, 2018b) and addressed non-radioactive chemicals in soil and sediment, as well as radiologically impacted media. Previous soil removals and placement of durable covers on upland areas and along the shoreline have achieved the RAO of preventing exposure to contaminants in soil and sediment. The durable covers are being maintained in accordance with the O&M Plan (ERRG, 2016), and access restrictions are in place (and will remain in place until the time of transfer) to limit exposure of property users to hazardous substances. Radiological remediation was completed in 2010; however, as described in Section 6.1.6, the supporting data were deemed unreliable and corrective actions are required to ensure the radiological remedy specified in the ROD is implemented as intended.

The remedy to address metals in groundwater is still being implemented. Performance monitoring following in-situ stabilization at IR-26 is being conducted in accordance with the RAMP (ChaduxTt, 2010d) and is expected to demonstrate the remedy is protective of San Francisco Bay. The continued maintenance of the durable cover and the effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will limit exposure of property users to hazardous substances following transfer of the property. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel B-2	**Protectiveness Determination:** Will Be Protective
Protectiveness Statement: The remedy for Parcel B-2 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date (including implementation of access restrictions) have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.	

8.4. PARCEL C

The remedy at Parcel C was partially completed in May 2016 (TtEC, 2017c and APTIM, 2018b) and addressed non-radioactive chemicals in soil. Previous soil removals and placement of durable covers have achieved the RAO of preventing exposure to contaminants in soil. The durable covers are being maintained in accordance with the O&M Plan (TtEC, 2017b), and access restrictions are in place (and will remain in place until the time of transfer) to limit exposure of property users to hazardous substances.

Radiological remediation was completed at most areas, except for Buildings 211 and 253; however, as described in Section 6.1.6, the supporting data were deemed unreliable and corrective actions are required to ensure the previous radiological remediation was implemented as intended. Radiological surveys and related remediation at Buildings 211 and 253 are still in the planning stages.

The remedy to address VOCs in soil gas and groundwater is still being implemented. Groundwater treatment was performed at plumes in RU-C1, RU-C4, and RU-C5; however, additional groundwater treatment is being planned for RU-C1, RU-C2, and RU-C5. Following treatment, performance monitoring at RU-C1, RU-C2, RU-C4, and RU-C5 is expected to demonstrate the remedy is protective of human health. Additionally, groundwater monitoring data collected along the bay margin have not identified any concentration trends that warrant additional action to ensure protection of human and ecological receptors.

Operation of the SVE system at Areas 1, 3, 4, 5, 6, 7, and 8 (located at RU-C1, RU-C4, and RU-C5) is ongoing, but its effectiveness is limited by subsurface conditions. SVE treatment in Area 2 is pending implementation of other RA activities to address soil and groundwater contamination. The Navy is currently evaluating the proposed SVE system operations plans in conjunction with the proposed soil excavation and groundwater treatment plans for these areas and will be issuing a report describing the proposed paths forward. Additional evaluation will be completed by December 2019 to determine if other measures could be implemented to enhance SVE system performance. Upon completion of this portion of the remedy, ICs will be relied upon in the future to limit exposure of property users to VOCs in soil gas and groundwater.

The continued maintenance of the durable cover and the effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will limit exposure of property users to hazardous substances following transfer of the property. This information supports the protectiveness statement provided in the table on the following page.

Site(s): Parcel C	**Protectiveness Determination:** Will Be Protective
Protectiveness Statement: The remedy for Parcel C is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date (including implementation of access restrictions) have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.	

8.5. PARCEL D-1

The remedy at Parcel D-1 was substantially completed in 2018 (ERRG, 2011 and 2014c; Shaw, 2014a; APTIM, 2018c; and Gilbane Federal, 2018a) and addressed non-radioactive chemicals in soil and soil gas, as well as radiologically impacted media. Previous soil removals and placement of durable covers have achieved the RAO of preventing exposure to contaminants in soil. The durable covers are being maintained in accordance with the O&M Plan (APTIM, 2018a), and access restrictions are in place (and will remain in place until the time of transfer) to limit exposure of property users to hazardous substances. Pre-ROD groundwater treatment using ZVI injection at IR-71 has been performed, and groundwater is being monitored in accordance with the RAMP (ChaduxTt, 2011d). Groundwater data collected to date have not identified any concentration trends that warrant additional action to ensure protection of human and ecological receptors.

Radiological remediation and surveys are complete. However, the fill history at a portion of Parcel D-1 raises the potential for radioactive objects to be encountered deeper than 2 feet, and the Navy is proposing ICs related to radionuclides in this area. The ICs for radionuclides will be defined in a forthcoming addendum to the LUC RD for Parcel D-1.

The maintenance of the durable cover and the effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will limit exposure of property users to hazardous substances following transfer of the property. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel D-1	**Protectiveness Determination:** Short-Term Protective
Protectiveness Statement: The remedy for Parcel D-1 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date (including implementation of access restrictions) have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.	

8.6. PARCEL D-2

The ROD was finalized in 2010 and concluded that no further action was necessary for Parcel D-2. At that time, radiological remediation had been completed as part of a basewide TCRA (TtEC, 2011c). However, as described in Section 6.1.6, the data supporting the radiological remediation were deemed unreliable and corrective actions are required to ensure the radiological remedy was implemented as intended.

Parcel D-2 was transferred out of federal ownership to the OCII in late 2015. Redevelopment activities were temporarily suspended pending completion of the corrective actions related to the radiological remediation. In the interim, access restrictions are in place to limit exposure of property users to hazardous substances. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel D-2	**Protectiveness Determination:** Short-Term Protective
Protectiveness Statement: The remedy for Parcel D-2 currently protects human health and the environment because (1) previous assessments determined there are no unacceptable risks from non-radioactive hazardous substances, and (2) access restrictions are in place while the corrective actions related to previous radiological remediation are completed. However, in order for the remedy to be protective in the long term, corrective actions are required to ensure the previous radiological remediation was implemented as intended and is protective of human health and the environment, as determined by Superfund guidance (EPA, 2012a).	

8.7. PARCEL E

The remedy at Parcel E will be implemented in phases, and the first phase of RA construction (related to non-radioactive chemicals in soil, soil gas, and groundwater) is planned to begin in late 2018. Radiological remediation was completed in some areas as part of a basewide TCRA; however, as described in Section 6.1.6, the supporting data were deemed unreliable and corrective actions are required to ensure the previous radiological remediation was implemented as intended. Radiological surveys and related remediation in areas not addressed by the basewide TCRA are still in the planning stages. Access restrictions are in place (and will remain in place until the time of transfer) to limit exposure of property users to hazardous substances. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel E	**Protectiveness Determination:** Will Be Protective
Protectiveness Statement: The remedy for Parcel E is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date (including implementation of access restrictions) have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.	

8.8. PARCEL E-2

The remedy at Parcel E-2 is being implemented in phases, and the first phase of RA construction was completed in 2017 (Gilbane Federal, 2018d). The Phase 2 RA construction is scheduled for completion in 2018, at which point the Phase 3 RA construction will begin. Access restrictions are in place (and will remain in place until the time of transfer) to limit exposure of property users to hazardous substances. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel E-2	**Protectiveness Determination:** Will Be Protective
Protectiveness Statement: The remedy for Parcel E-2 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date (including implementation of access restrictions) have adequately addressed all exposure pathways that could result in unacceptable risks in these areas.	

8.9. PARCEL G

The remedy at Parcel G was completed in July 2014 (ERRG, 2011; TtEC, 2011b; ARCADIS, 2014a) and addressed non-radioactive chemicals in soil, soil gas, and groundwater, as well as radiologically impacted media. Previous soil removals and placement of durable covers have achieved the RAO of preventing exposure to contaminants in soil. The durable covers are being maintained in accordance with the O&M Plan (ARCADIS, 2014b), and access restrictions are in place (and will remain in place until the time of transfer) to limit exposure of property users to hazardous substances. Radiological remediation was completed in 2011; however, as described in Section 6.1.6, the supporting data were deemed unreliable and corrective actions are required to ensure the radiological remedy specified in the ROD is implemented as intended.

Pre-ROD groundwater treatment using ZVI injection at IR-09 and IR-71 has been performed, and groundwater is being monitored in accordance with the RAMP (ChaduxTt, 2010c). Groundwater data collected to date have not identified any concentration trends that warrant additional action to ensure protection of human and ecological receptors. The continued maintenance of the durable cover and the effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will limit exposure of property users to hazardous substances following transfer of the property. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel G	**Protectiveness Determination:** Short-Term Protective
Protectiveness Statement: The remedy for Parcel G currently protects human health and the environment because (1) previous remedial activities have adequately addressed exposure pathways to non-radioactive hazardous substances, and (2) access restrictions are in place while the corrective actions related to previous radiological remediation are completed. However, in order for the remedy to be protective in the long term, corrective actions are required to ensure the previous radiological remediation was implemented as intended and is protective of human health and the environment, as determined by Superfund guidance (EPA, 2012a).	

8.10. PARCEL UC-1

The remedy at Parcel UC-1 was completed in September 2012 (ERRG, 2013c and TtEC, 2011a) and addressed non-radioactive chemicals in soil and soil gas, as well as radiologically impacted media. Previous placement of durable covers have achieved the RAO of preventing exposure to contaminants in soil. The durable covers are being maintained in accordance with the O&M Plan (ERRG, 2013d), and ICs are being implemented to limit exposure of property users to hazardous substances. Radiological remediation was completed in 2010; however, as described in Section 6.1.6, the supporting data were deemed unreliable and corrective actions are required to ensure the radiological remedy specified in the ROD is implemented as intended.

The continued maintenance of the durable covers and the effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, are limiting exposure of property users to hazardous substances. Parcel UC-1 was transferred out of federal ownership to the OCII in late 2015. The OCII's developer is performing inspection and maintenance, in accordance with an approved Risk Management Plan (Geosyntec Consultants, 2015), to ensure the integrity of the durable covers and the effective implementation of ICs. Redevelopment activities were temporarily suspended pending completion of the corrective actions related to the radiological remediation. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel UC-1	**Protectiveness Determination:** Short-Term Protective
Protectiveness Statement: The remedy for Parcel UC-1 currently protects human health and the environment because (1) previous remedial activities have adequately addressed exposure pathways to non-radioactive hazardous substances, and (2) redevelopment activities are suspended while the corrective actions related to previous radiological remediation are completed. However, in order for the remedy to be protective in the long term, corrective actions are required to ensure the previous radiological remediation was implemented as intended and is protective of human health and the environment, as determined by Superfund guidance (EPA, 2012a).	

8.11. PARCEL UC-2

The remedy at Parcel UC-2 was completed in September 2012 (ERRG, 2013c; TtEC, 2011a) and addressed non-radioactive chemicals in soil, soil gas, and groundwater, as well as radiologically impacted media. Previous placement of durable covers have achieved the RAO of preventing exposure to contaminants in soil. The durable covers are being maintained in accordance with the O&M Plan (ERRG, 2013d), and ICs are being implemented to limit exposure of property users to hazardous substances. Groundwater is being monitoring in accordance with the RAMP (ChaduxTt, 2010a), and data collected to date have not identified any concentration trends that warrant additional action to ensure protection of human and ecological receptors. Radiological remediation was completed in 2010; however, as described in Section 6.1.6, the supporting data were deemed unreliable and corrective actions are required to ensure the radiological remedy specified in the ROD is implemented as intended.

The continued maintenance of the durable covers and the effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, are limiting exposure of property users to hazardous substances. Parcel UC-2 was transferred out of federal ownership to the OCII in late 2015. The OCII's developer is performing inspection and maintenance, in accordance with an approved Risk Management Plan (Geosyntec Consultants, 2015), to ensure the integrity of the durable covers and the effective implementation of ICs. Redevelopment activities were temporarily suspended pending completion of the corrective actions related to the radiological remediation. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel UC-2	**Protectiveness Determination:** Short-Term Protective
Protectiveness Statement: The remedy for Parcel UC-2 currently protects human health and the environment because (1) previous remedial activities have adequately addressed exposure pathways to non-radioactive hazardous substances, and (2) redevelopment activities are suspended while the corrective actions related to previous radiological remediation are completed. However, in order for the remedy to be protective in the long term, corrective actions are required to ensure the previous radiological remediation was implemented as intended and is protective of human health and the environment, as determined by Superfund guidance (EPA, 2012a).	

8.12. PARCEL UC-3

The remedy at Parcel UC-3 was substantially completed in November 2017 (Gilbane Federal, 2018e; TtEC, 2012b) and addressed non-radioactive chemicals in soil, soil gas, and groundwater, as well as radiologically impacted media. Previous soil removals and placement of durable covers have achieved the RAO of preventing exposure to contaminants in soil. The durable covers are being maintained in accordance with the O&M Plan (Gilbane Federal, 2018f), and access restrictions are in place (and will remain in place until the time of transfer) to limit exposure of property users to hazardous substances. Groundwater monitoring was conducted in accordance with the RAMP (Amec Foster Wheeler, 2016a), and data collected demonstrated the remedy is protective of human health. Radiological remediation was completed in 2011; however, as described in Section 6.1.6, the supporting data were deemed unreliable and corrective actions are required to ensure the radiological remedy specified in the ROD is implemented as intended.

The continued maintenance of the durable cover and the effective implementation of ICs, through land use and activity restrictions incorporated into deeds and CRUPs at the time of transfer, will effectively limit exposure of property users to hazardous substances following transfer of the property. This information supports the protectiveness statement provided in the table below.

Site(s): Parcel UC-3	**Protectiveness Determination:** Short-Term Protective
Protectiveness Statement: The remedy for Parcel UC-3 currently protects human health and the environment because (1) previous remedial activities have adequately addressed exposure pathways to non-radioactive hazardous substances, and (2) access restrictions are in place while the corrective actions related to previous radiological remediation are completed. However, in order for the remedy to be protective in the long term, corrective actions are required to ensure the previous radiological remediation was implemented as intended and is protective of human health and the environment, as determined by Superfund guidance (EPA, 2012a).	

Section 9. Next Review

The next five-year review will be completed in 2023.

Figures

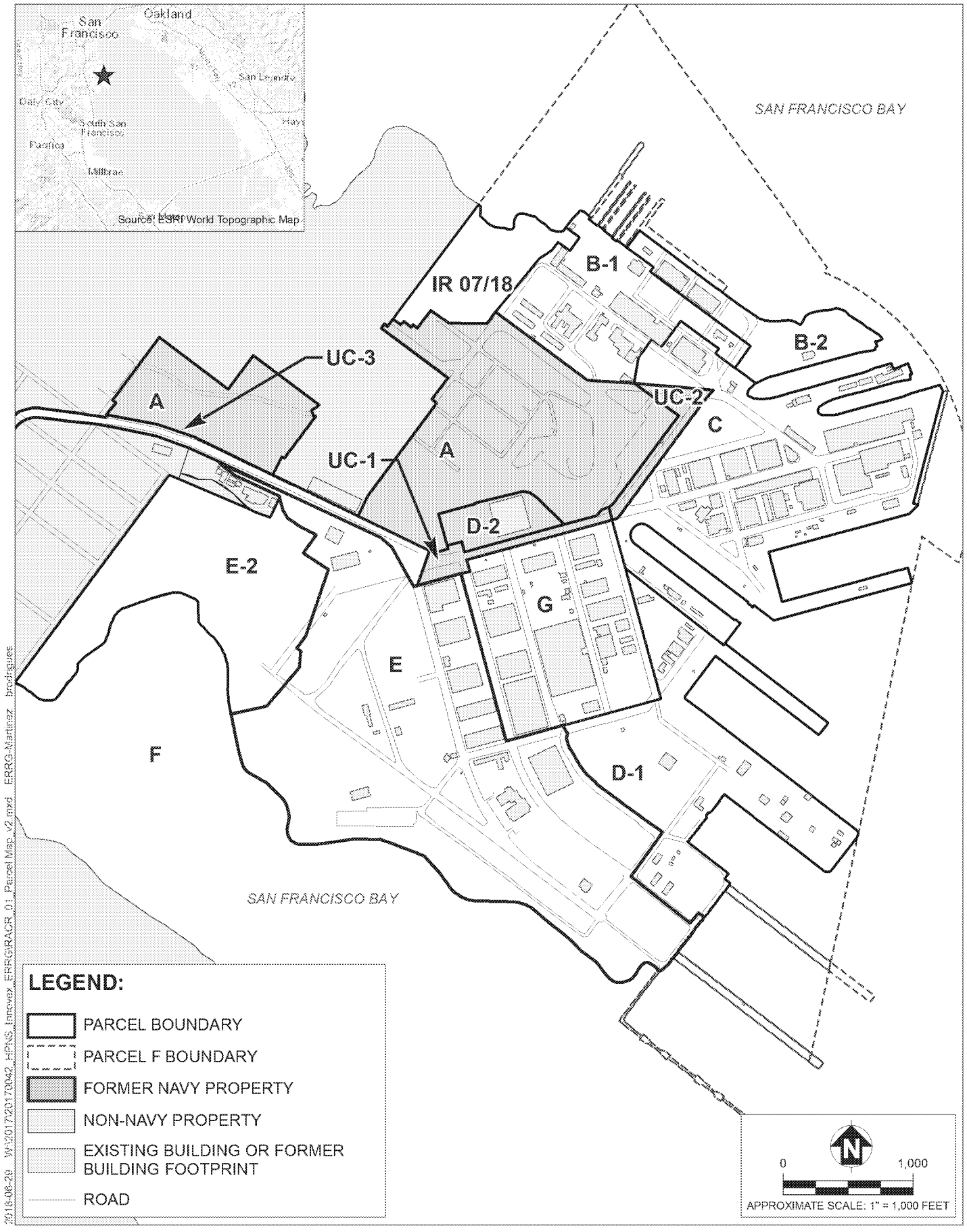


Figure 1. Parcel Map

Fourth Five-Year Review of Remedial Actions, Hunters Point Naval Shipyard, San Francisco, California

Hunters Point Naval Shipyard, San Francisco, California
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2
INSTALLATION RESTORATION SITES

W:\2017\20170042_HPNS_Innovex_ERRG\RACR_02_IR_Sites_rev1.mxd Last updated: 6/29/2018 at 4:51:31 PM

NON-NAVY PROPERTY

EARL STREET

INNES AVENUE

IR18MW21A

IR18MW100B

IR07MW23A

SETTLEMENT MONUMENT 2

IR18MW101B

IR18MW92A

DRAINAGE SWALE

IR07MW94A

IR07MW25A

IR07MW24A

IR07MW21A1

SHORELINE REVETMENT

SAN FRANCISCO BAY

CREST OF REVETMENT

TOE OF REVETMENT

MLLW = −3.56 MSL

3 FT. OF COVER

IR07MW93A

IR07MWS−4

2 FT. OF COVER

SETTLEMENT MONUMENT 1

IR07MW26A

SG−PT18

SG−PT19

SG−PT17

SG−PT15

SG−PT16

DONAHUE STREET

IR07MWS−2

IR07MW20A1

EXISTING DRAINAGE CHANNEL

BUILDING 117

LEGEND:

- SHORELINE REVETMENT (RIPRAP)
- ASPHALT COVER
- GROUNDWATER MONITORING WELL
- FORMER METHANE MONITORING PROBE
- SETTLEMENT MONUMENT
- DRAINAGE SWALE
- AREA REQUIRING INSTITUTIONAL CONTROLS FOR POTENTIAL RADIONUCLIDES
- IR−07 BOUNDARY
- IR−18 BOUNDARY
- EXISTING TOPOGRAPHIC CONTOUR
- FINAL TOPOGRAPHIC CONTOUR 3−FT. COVER
- FINAL TOPOGRAPHIC CONTOUR 2−FT. COVER
- FINAL TOPOGRAPHIC CONTOUR REVETMENT
- FENCE

0' 120'

SCALE: 1"=120'

CLIENT: DEPARTMENT OF THE NAVY BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR IR−07/18			
LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: SC 04/18/12	CHECKED BY: JS 04/18/12	PROJECT NO. 20170042	FIG NO. 3

FILE NAME: G:\Civil 3D Projects\ERRG\Projects\20170042\figures_8-1\O&M 5 year\Fig-3.dwg LAYOUT NAME: 3 PLOTTED: Thursday, September 20, 2018 - 5:49pm

ED_006060B_00000486-00107

SAN FRANCISCO BAY

DRY DOCK 7

DRY DOCK 6

DRY DOCK 5

159

128

130

125

156

146

121

122

123

120

113

113A

116

115

117

109

103

104

SM 3

SM 2

SM 1

IR46MW43A

IR46MW60A

IR46MW57A

R46MW56A

IR45MW59A

IR46MW58A

IR26MW41A

IR10MW31A1

IR46MW38A

IR46MW61A

IR20MW17A

IR25MW61A2

IR25MW61A1

IR10MW32A

IR10MW13A1

IR10MW80A

IR10MW81A

IR10MW82A

IR10MW79A

IR10MW61A

IR10MW63A

IR10MW59A

IR10MW71A

IR10MW28A

IR10MW82A

UT03MW16A

IR61MW05A

IR06MW46A

IR62MW07A

UT02MW15A

IR62MW08A

GALVEZ AVENUE

ROBINSON STREET

LEGEND:

- 123 — EXISTING BUILDING WITH RESTORED FOUNDATION
- SHORELINE REVETMENT COVER
- ASPHALT OR CONCRETE COVER
- VEGETATED SOIL COVER
- GROUNDWATER TREATMENT AREA
- IR26MW43A — GROUNDWATER MONITORING WELL
- SETTLEMENT MONUMENT
- IR-10 CARVE-OUT BOUNDARY
- NON-NAVY PROPERTY
- PARCEL B-1 BOUNDARY
- OTHER PARCEL LINE
- 10 — OFFSITE TOPOGRAPHIC CONTOUR LINE
- 10 — POST-CONSTRUCTION TOPOGRAPHIC CONTOUR LINE
- DRAINAGE SWALE
- EDGE OF PAVEMENT
- X — FENCE

0' 120'

CLIENT: DEPARTMENT OF THE NAVY BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL B-1			
LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: SC 09/27/16	CHECKED BY: JS 09/27/16	PROJECT NO. 20170042	FIG NO. 4

FILE NAME: C:\Civil 3D Projects\ERRG\Projects\20170042\figures_B-1\O&M 5 year\Fig-4.dwg LAYOUT NAME: 4 PLOTTED: Saturday, June 30, 2018 - 1:09pm

SAN FRANCISCO BAY

DRY DOCK 6

DRY DOCK 5

DRY DOCK 2

DRY DOCK 3

GATE

IR46MW46A IR46MW47A IR46MW48A IR46MW57A IR46MW60A IR46MW59A IR46MW56A IR46MW58A IR46MW41A IR46MW38A IR46MW61A

IR26MW51A IR26MW50A IR26MW49A IR26MW46A IR26MW48A IR26MW43A IR26MW41A IR26MW60A IR26MW44A PA50MW02A

IR20MW17A

IR25MW61A2 IR25MW61A1

IR10MW31A1 IR10MW32A IR10MW13A1 IR10MW80A IR10MW81A IR10MW62A IR10MW79A IR10MW63A IR10MW61A IR10MW59A IR10MW71A IR10MW28A IR10MW82A

IR06MW46A IR62MW07A IR62MW08A

UT03MW16A IR6 MW05A UT02MW15A

SM 3 SM 4 SM 1

159 128 130 125 156 140 123 134 121 122 120 113 113A 116 115 109

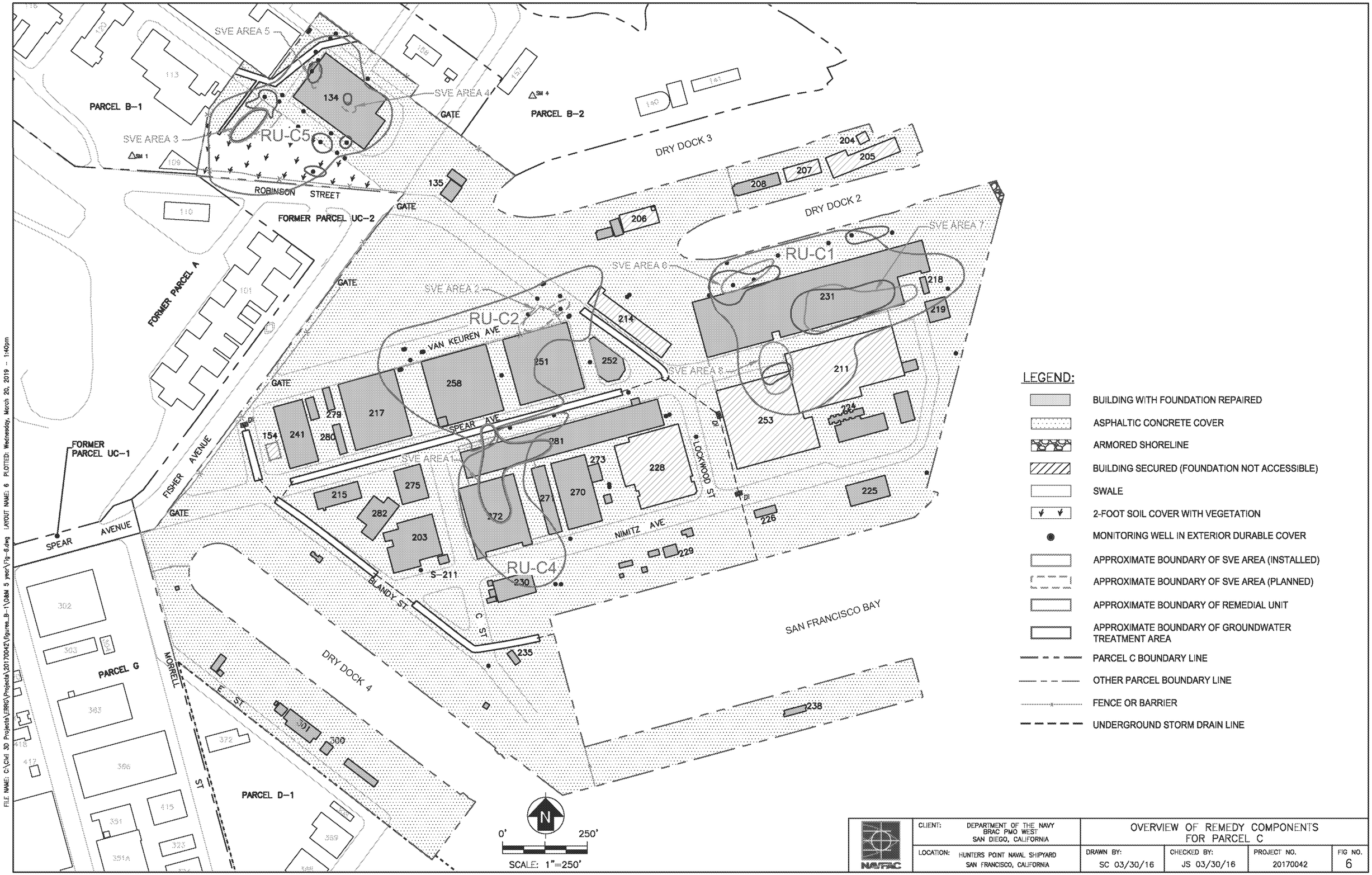
0' 160'

LEGEND:

- 123 — EXISTING BUILDING WITH RESTORED FOUNDATION
- SHORELINE REVETMENT COVER
- ASPHALT OR CONCRETE COVER
- GROUNDWATER TREATMENT AREA
- IR26MW43A — GROUNDWATER MONITORING WELL
- SETTLEMENT MONUMENT
- NON–NAVY PROPERTY
- PARCEL B–1 BOUNDARY
- OTHER PARCEL LINE
- 10 — OFFSITE TOPOGRAPHIC CONTOUR LINE
- 10 — POST–CONSTRUCTION TOPOGRAPHIC CONTOUR LINE
- DRAINAGE SWALE
- EDGE OF PAVEMENT
- X — FENCE

CLIENT: DEPARTMENT OF THE NAVY BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL B–2			
LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: PR 09/21/17	CHECKED BY: JS 09/21/17	PROJECT NO. 20170042	FIG NO. 5

FILE NAME: C:\Civil 3D Projects\ERRG\Projects\20170042\Figures_B-1\O&M 5 year\Fig-5.dwg LAYOUT NAME: 5 PLOTTED: Saturday, June 30, 2018 – 1:11pm



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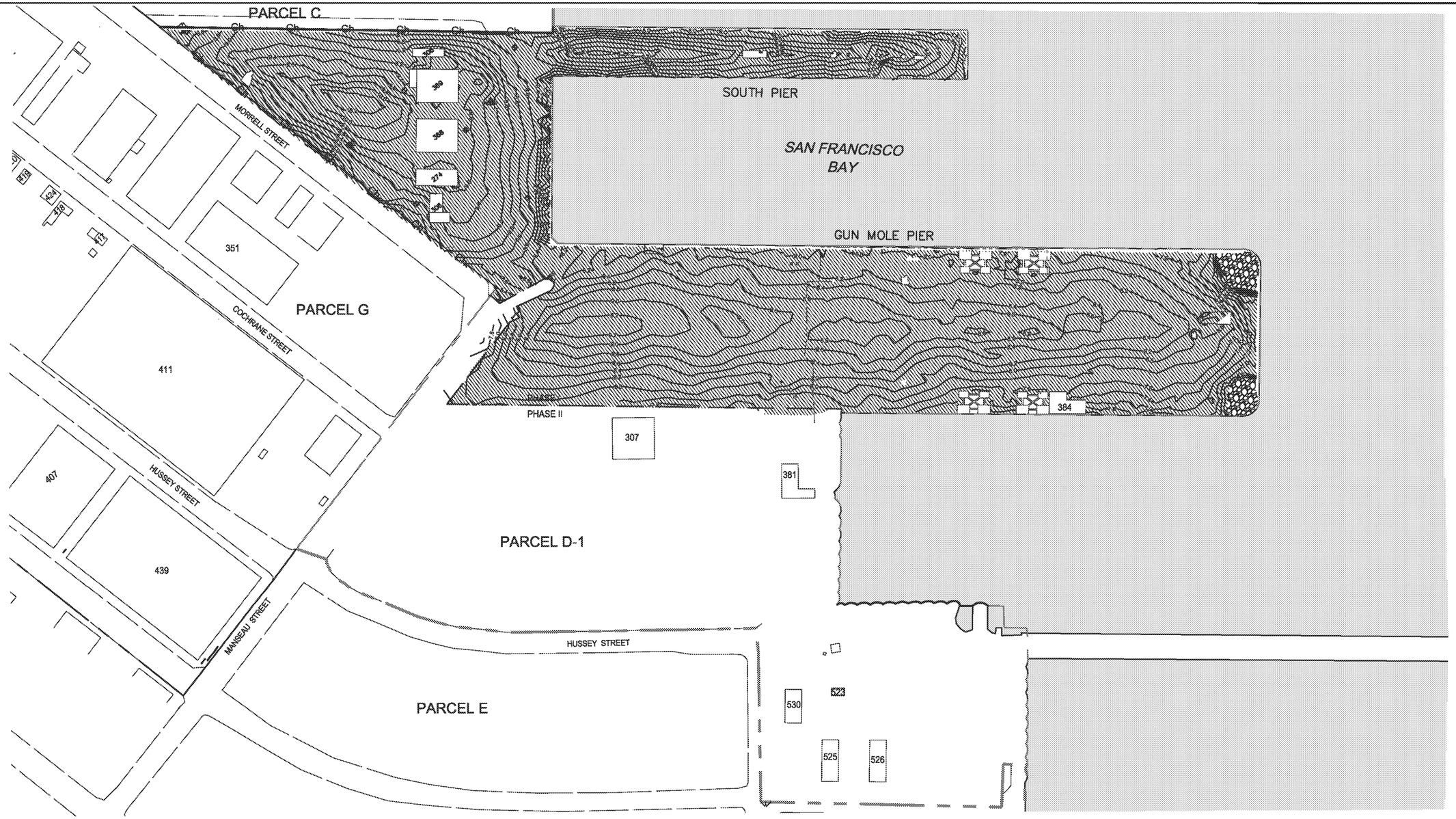
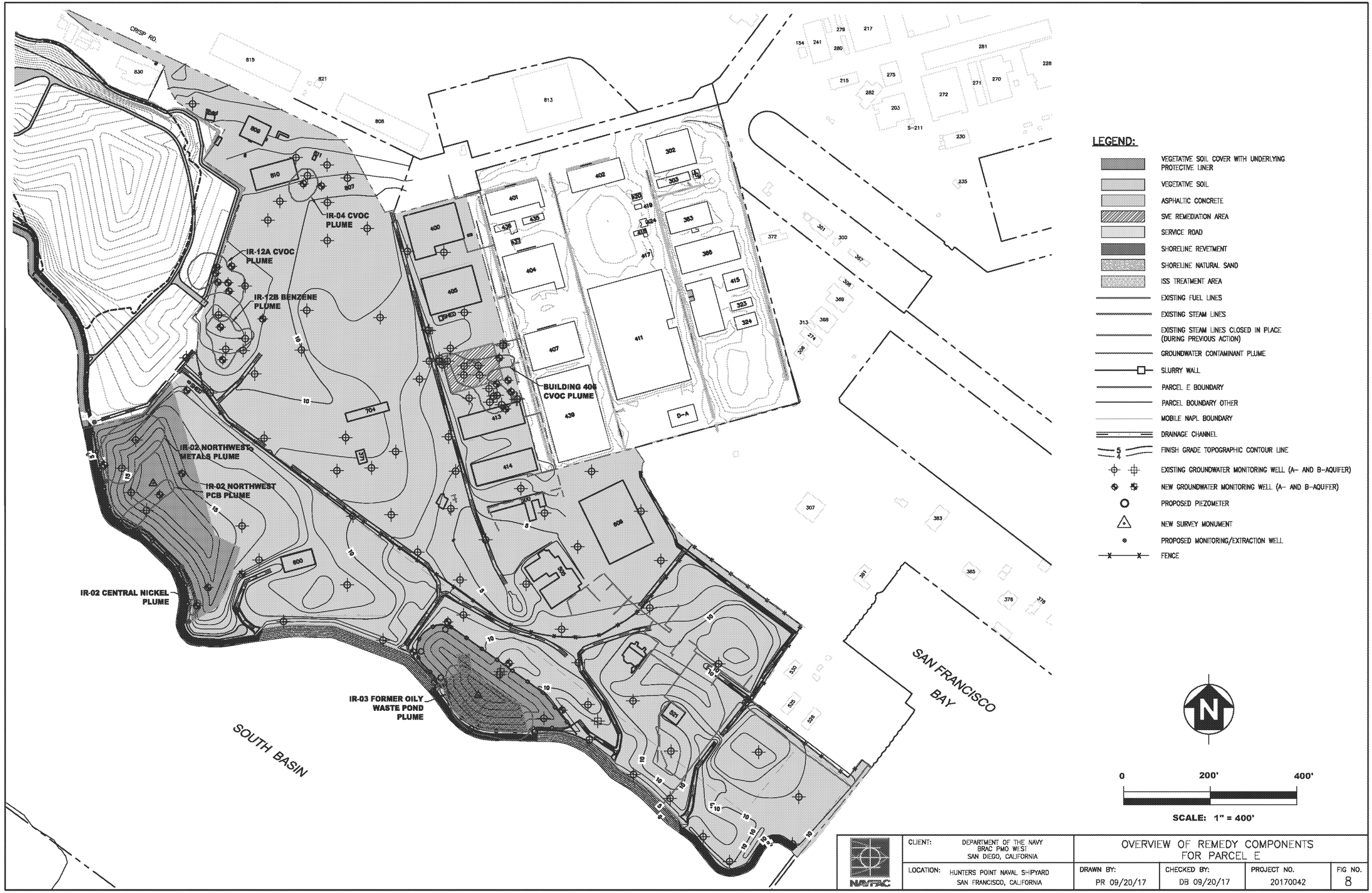
NAVFAC	CLIENT: DEPARTMENT OF THE NAVY BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL C			
	LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: SC 03/30/16	CHECKED BY: JS 03/30/16	PROJECT NO. 20170042	FIG NO. 6



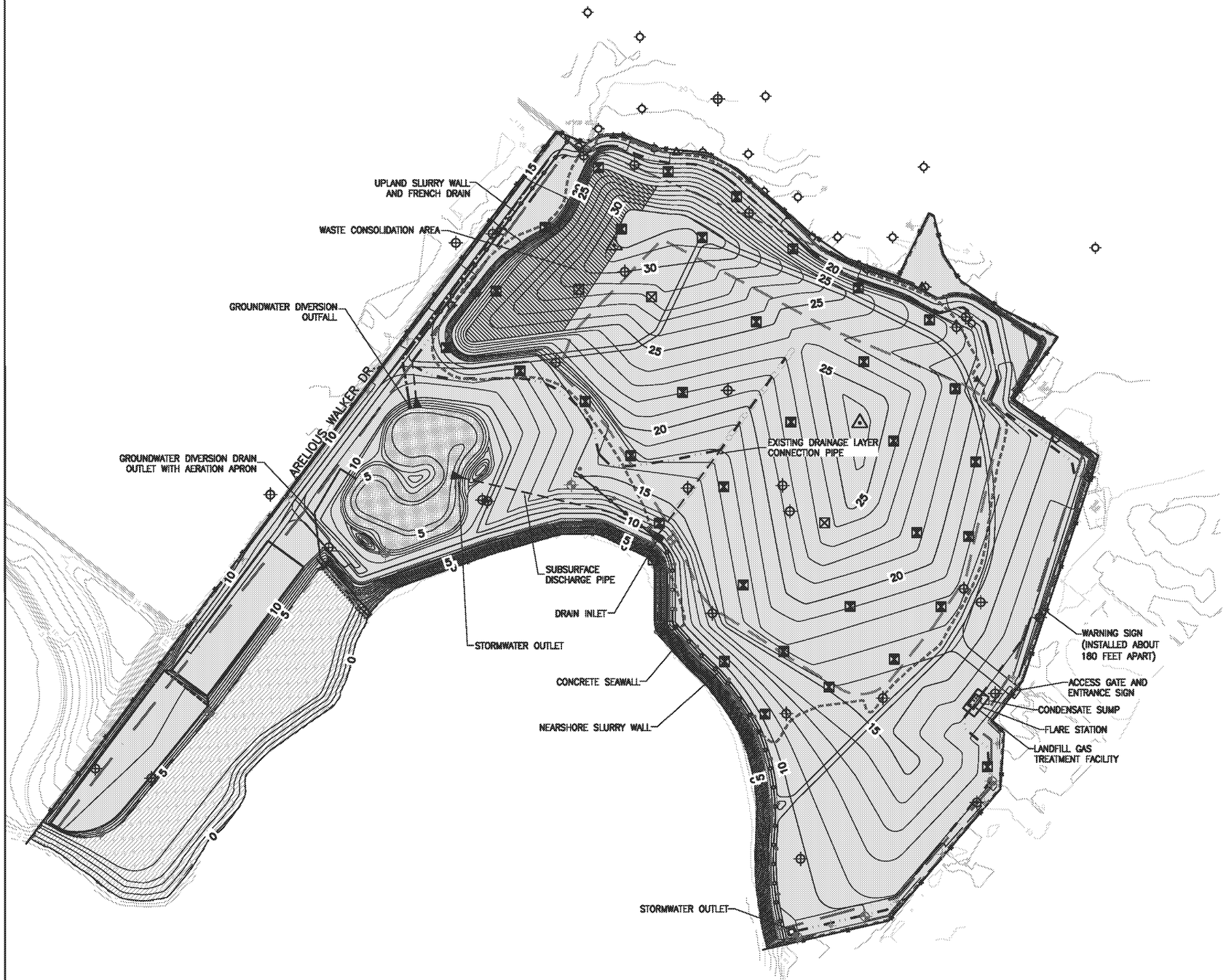
NAVFAC	CLIENT: DEPARTMENT OF THE NAVY BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL D-1		
	LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: PR 09/21/17	CHECKED BY: JS 09/21/17	PROJECT NO. 20170042	FIG NO. 7

FILE NAME: C:\Civil 3D Projects\ERRG\Projects\20170042\figures_B-1\O&M 5 year\Fig-7.dwg LAYOUT NAME: 7 PLOTTED: Saturday, June 30, 2018 - 1:23pm



FILE NAME: C:\Civil 3D Projects\ERRG\Projects\20170042\Figures_B-1\O&M 5 year\Fig-8.dwg LAYOUT NAME: 8 PLOTTED: Saturday, November 03, 2018 - 10:34am

CLIENT: DEPARTMENT OF THE NAVY BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL E			
LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: PR 09/20/17	CHECKED BY: DB 09/20/17	PROJECT NO. 20170042	FIG NO. 8



LEGEND:

- FINAL COVER
- WASTE CONSOLIDATION AREA
- FRESHWATER WETLAND (NO GEOSYNTHETIC CAP)
- TIDAL WETLAND
- SERVICE ROAD
- RIPRAP REVETMENT SLOPE PROTECTION
- PARCEL E-2 BOUNDARY
- GROUNDWATER DIVERSION DRAIN
- LIMIT OF LANDFILL WASTE
- APPROXIMATE LIMIT OF GEOSYNTHETIC CAP
- APPROXIMATE LIMIT OF EXISTING GEOSYNTHETIC CAP
- PERIMETER DRAINAGE CHANNEL
- EXISTING GROUNDWATER MONITORING WELL (TO REMAIN)
- EXISTING GAS MONITORING PROBE
- EXISTING LFG VENT
- EXISTING LFG VENT (TO BE DECOMMISSIONED)
- EXISTING LFG ROI TEST WELL
- NEW PIEZOMETER
- NEW GAS MONITORING PROBE
- NEW GROUNDWATER MONITORING WELL
- NEW LANDFILL GAS EXTRACTION WELL
- NEW LEACHATE MONITORING/EXTRACTION WELL
- NEW SURVEY MONUMENT
- DRAIN INLET
- FINISH GRADE TOPOGRAPHIC CONTOUR LINE
- EXISTING TOPOGRAPHIC CONTOUR LINE
- SLURRY WALL
- FENCE

N

0 125' 250'

SCALE: 1" = 250'

NAVFAC	CLIENT: DEPARTMENT OF THE NAVY BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL E-2			
	LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: PR 09/20/17	CHECKED BY: DB 09/20/17	PROJECT NO. 20170042	FIG NO. 9

FILE NAME: C:\Civil 3D Projects\ERRG\Projects\20170042\Figures_8-11\O&M 5 year\Fig-9.dwg LAYOUT NAME: 9 PLOTTED: Saturday, November 03, 2018 - 10:43am

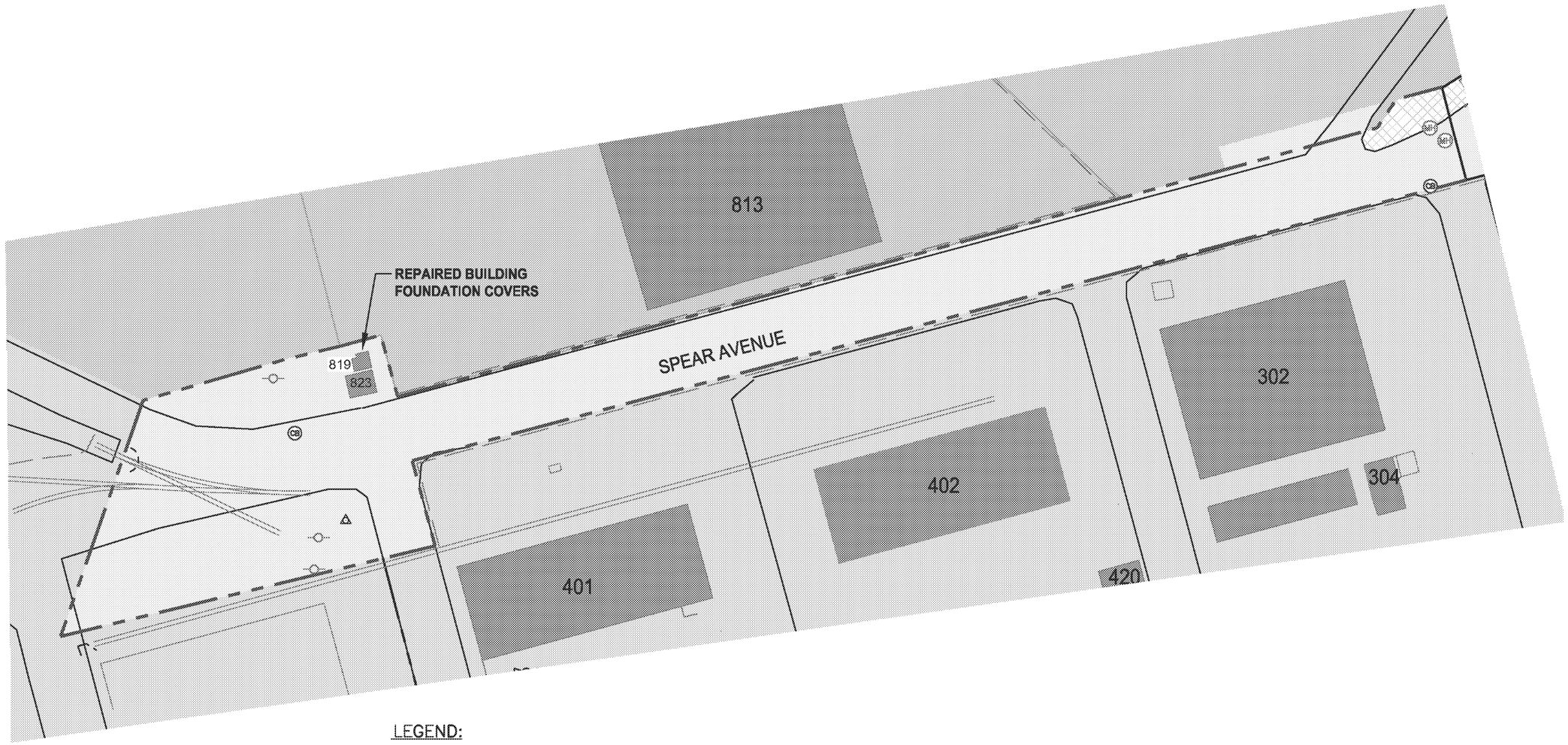
LEGEND:

- SEAL COAT APPLICATION (11%)
- 2" AC OVERLAY ON EXISTING AC (5%)
- CONCRETE PATCHING AND SHOTCRETE (6%)
- CRACK REPAIR/SEALING ON BUILDING SLAB (34%)
- NEW PAVEMENT CONSTRUCTION (44%) (REMAINDER OF SITE)
- DRAINAGE SWALE
- PARCEL BOUNDARY

0 200 Feet

NAVFAC	CLIENT: DEPARTMENT OF THE NAVY BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL G			
	LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: SC 03/30/16	CHECKED BY: JS 03/30/16	PROJECT NO. 20170042	FIG NO. 10

FILE NAME: C:\Civil 3D Projects\ERRG\Projects\20170042\figures_B-1\O&M 5 years\Fig-10.dwg LAYOUT NAME: 10 PLOTTED: Saturday, June 30, 2018 - 1:26pm



LEGEND:

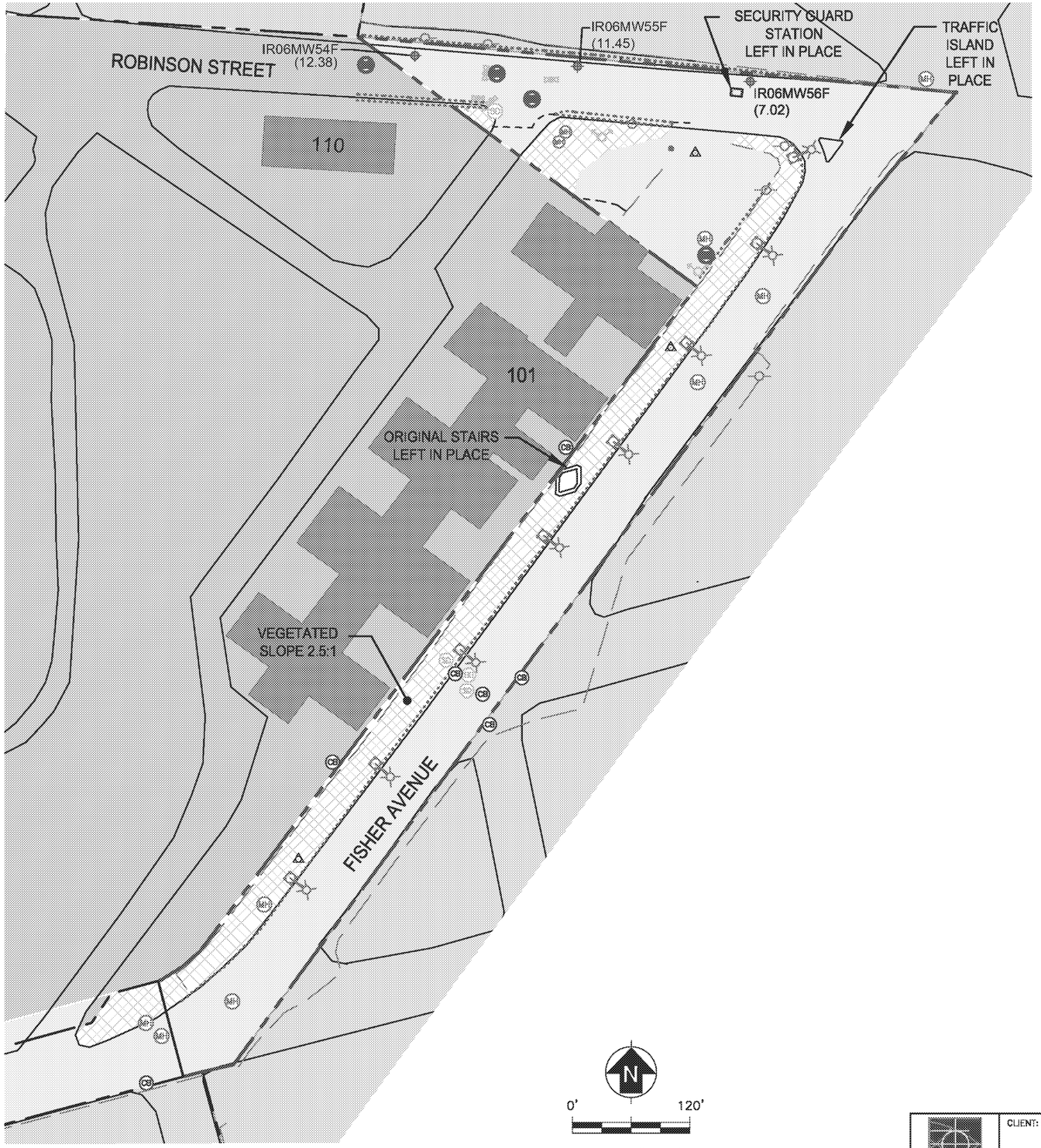
- EXISTING BUILDING
- ASPHALT PAVEMENT COVER
- SOIL COVER
- ADJACENT NAVY PARCEL(S)
- ADJACENT NON-NAVY PROPERTY
- CB CATCH BASIN
- SMH MANHOLE
- SETTLEMENT MONUMENT
- UTILITY POLE APPROX. LOCATION
- PARCEL BOUNDARY
- FENCE
- RAILROAD TRACK

N

0' 120'

SCALE: 1"=120'

NAVFAC	CLIENT: DEPARTMENT OF THE NAVY, BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL UC-1		
	LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: SC 03/14/14	CHECKED BY: JS 03/14/14	PROJECT NO. 20170042	FIG NO. 11



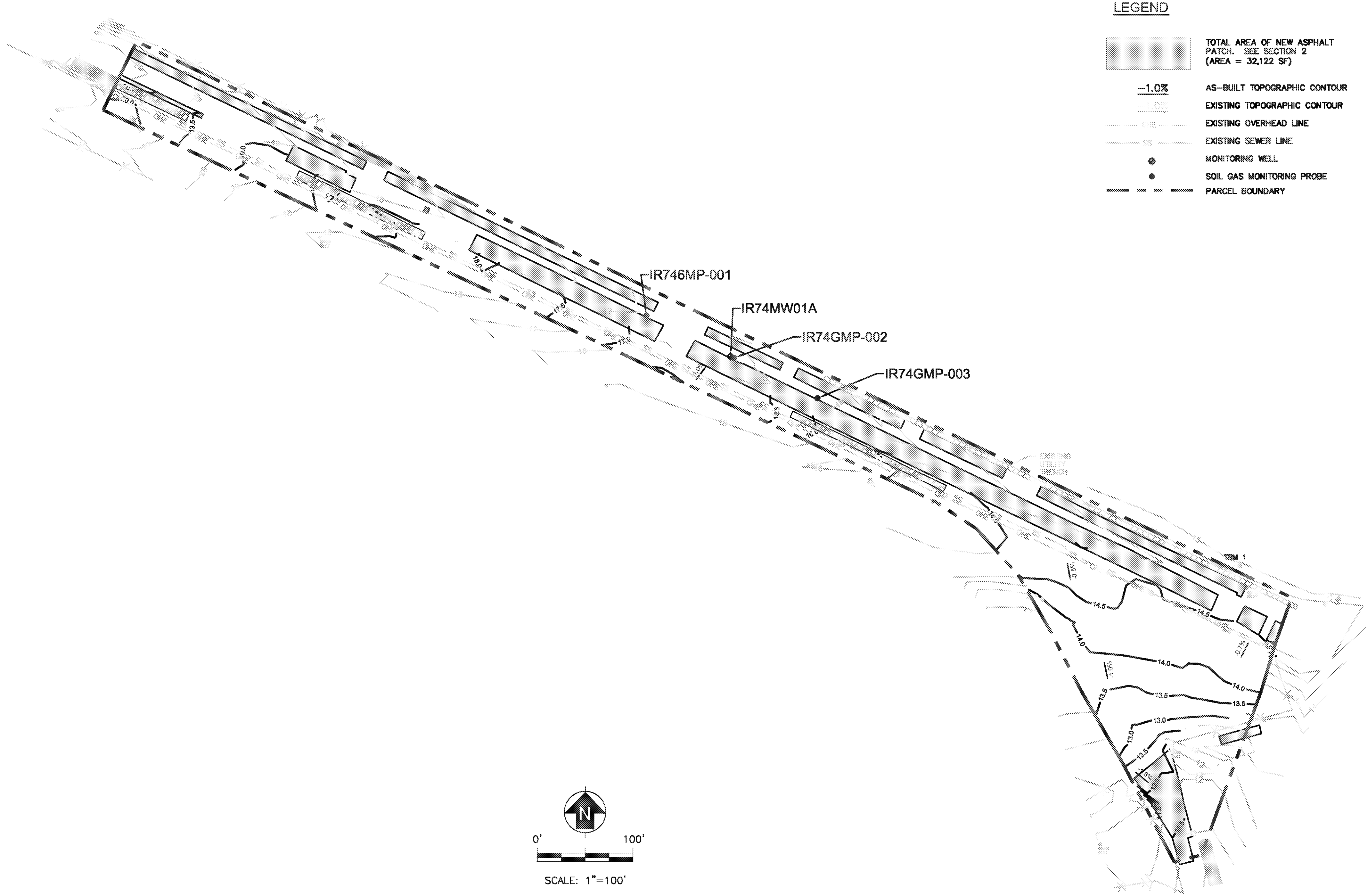
LEGEND:

IR06MW54F	MONITORING WELL AND WELL ID
(12.38)	WATER LEVEL ELEVATION (MSL)*
	EXISTING BUILDING
	ASPHALT PAVEMENT COVER
	SOIL COVER
	ADJACENT NAVY PARCEL
	ADJACENT NON-NAVY PROPERTY
	PARCEL BOUNDARY
	CATCH BASIN
	MANHOLE
	SANITARY SEWER
	STORM DRAIN
	SETTLEMENT MONUMENT
	FIRE HYDRANT
	WATER VALVE
	UTILITY FEATURE STREET LIGHT
	UTILITY POLE APPROX. LOCATION
	UTILITY FEATURE
	FENCE
	CONCRETE WALL

NAVFAC	CLIENT: DEPARTMENT OF THE NAVY, BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL UC-2			
	LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: SC 03/14/14	CHECKED BY: JS 03/14/14	PROJECT NO. 20170042	FIG NO. 12

FILE NAME: C:\Civil 3D Projects\ERRG\Projects\20170042\figures_B-1\O&M 5 year\Fig-12.dwg LAYOUT NAME: 12 PLOTTED: Saturday, June 30, 2018 - 1:30pm

FILE NAME: C:\Civil 3D Projects\ERRG\Projects\20170042\figures_B-1\O&M 5 year\Fig-13.dwg LAYOUT NAME: 13 PLOTTED: Thursday, September 20, 2018 -- 5:49pm



CLIENT: DEPARTMENT OF THE NAVY, BRAC PMO WEST SAN DIEGO, CALIFORNIA	OVERVIEW OF REMEDY COMPONENTS FOR PARCEL UC-3			
LOCATION: HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA	DRAWN BY: PR 09/20/18	CHECKED BY: DB 09/20/18	PROJECT NO. 20170042	FIG NO. 13

ED_006060B_00000486-00117

Tables

Table 1. Chemicals of Concern and Contaminated Media
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

	Parcel																																																
	B (including IR-07/18 and B-1 and B-2)							C						D-1					D-2	E						E-2						F		G					UC-1			UC-2				UC-3			
Chemical	Soil	Sediment	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[3]	Groundwater, Vapor Intrusion	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil and Structures, Radionuclides	Soil	Sediment	Soil Gas[3]	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil, Human Health and Terrestrial Wildlife	Sediment	Soil Gas	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Sediment	Sediment, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[2]	Soil and Structures, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Soil and Structures, Radionuclides	Soil	Soil Gas[2]	Groundwater	Soil and Structures, Radionuclides
1,1,2,2-Tetrachloroethane										X																																							
1,1,2-Trichloroethane										X																																							
1,1-Dichloroethane										X	X																		X																				
1,1-Dichloroethene																							X																										
1,2,3-Trichloropropane										X																			X																				
1,2,4-Trichlorobenzene				X							X									X																													
1,2,4-Trimethylbenzene				X						X	X									X																													
1,2-Dichlorobenzene				X						X	X																																						
1,2-Dichloroethane				X				X		X	X																		X																				
1,2-Dichloroethene (total)				X						X	X																																						
1,2-Dichloropropane				X						X	X																																						
1,3,5-Trimethylbenzene				X						X	X									X																													
1,3-Dichlorobenzene											X																																						
1,4-Dichlorobenzene				X	X			X		X	X												X						X																				
2,4-Dimethylphenol											X																																						
2,4-Dinitrotoluene											X																																						
2-Methylnaphthalene				X				X			X																																						
2-Methylphenol											X																																						
3,3'-Dichlorobenzidine								X												X																													
4-Methylphenol											X																																						
4-Nitrophenol																				X									X																				
4,4'-DDD																				X																													
4,4'-DDE																				X																													
4,4'-DDT																										X																							
Aldrin											X									X																													
alpha-BHC											X									X																													
Aluminum		X																																															
Americium-241																									X																								
Antimony	X				X			X			X									X						X	X																						
Aroclor-1016																										X			X																				
Aroclor-1242																										X			X																				
Aroclor-1248																				X						X																							
Aroclor-1254	X							X												X						X			X																				
Aroclor-1260	X							X												X						X			X																				
Arsenic	X				X			X			X			X						X			X			X			X					X								X							

Table 1. Chemicals of Concern and Contaminated Media *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

	Parcel																																																
	B (including IR-07/18 and B-1 and B-2)							C						D-1					D-2	E						E-2						F		G					UC-1			UC-2				UC-3			
Chemical	Soil	Sediment	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[3]	Groundwater, Vapor Intrusion	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil and Structures, Radionuclides	Soil	Sediment	Soil Gas[3]	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil, Human Health and Terrestrial Wildlife	Sediment	Soil Gas	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Sediment	Sediment, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[2]	Soil and Structures, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Soil and Structures, Radionuclides	Soil	Soil Gas[2]	Groundwater	Soil and Structures, Radionuclides
Benzene			X	X	X			X		X	X				X	X				X									X						X	X				X			X				X		
Benzo(a)anthracene	X							X			X									X						X			X																	X			
Benzo(a)pyrene	X							X			X			X						X						X			X					X												X			
Benzo(b)fluoranthene	X							X						X						X						X			X					X												X			
Benzo(k)fluoranthene	X							X												X						X			X																	X			
beta-BHC	X																												X																				
bis(2-Ethylhexyl)phthalate	X							X			X									X									X																				
Bromodichloromethane			X	X						X	X																																						
Cadmium	X							X												X	X					X																							
Carbazole											X									X																													
Carbon Tetrachloride										X						X													X						X	X								X					
Cesium-137							X						X					X	X						X						X		X					X			X				X				X
Chlorobenzene				X						X	X																																						
Chloroethane				X	X					X	X																																						
Chloroform			X	X						X	X				X	X													X						X	X				X				X					
Chromium VI						X					X	X					X												X								X												
Chrysene								X			X									X									X																				
cis-1,2-Dichloroethene				X						X	X												X																										
cis-1,3-Dichloropropene										X																																							
Cobalt-60							X						X					X							X						X		X					X			X								
Copper	X	X				X		X												X	X					X	X					X														X			
Dibromochloromethane										X																																							
Dichlorodifluoromethane				X																																													
Dibenz(a,h)anthracene	X	X						X												X						X			X																	X			
Dibenzofuran											X																																						
Dieldrin	X	X						X			X									X						X	X		X																				
Dioxin																										X																							
Dioxins/furans																				X																													
Endrin																											X																						
Ethylbenzene															X																																		
gamma-BHC (Lindane)								X												X																													
Heptachlor																													X																				
Heptachlor epoxide	X							X			X									X						X			X																				
Heptachlor epoxide A																													X																				
Heptachlor epoxide B																													X																				

Table 1. Chemicals of Concern and Contaminated Media *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Chemical	Parcel B (including IR-07/18 and B-1 and B-2)							Parcel C						Parcel D-1					Parcel D-2
	Soil	Sediment	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[3]	Groundwater, Vapor Intrusion	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil and Structures, Radionuclides
Hexachlorobenzene								X											
Hexachloroethane											X								
Hydrogen-3																		X	
Indeno(1,2,3-cd)pyrene	X							X											
Iron	X							X			X								
Isopropylbenzene										X									
Lead	X	X				X		X											
Manganese	X				X			X			X			X					
Mercury	X			X		X		X											
Methylene Chloride				X						X	X				X				
Methoxychlor		X																	
Molybdenum																			
Naphthalene	X			X				X		X	X					X			
Nickel						X		X									X		
n-Nitroso-di-n-propylamine								X											
n-Nitrosodiphenylamine																			
Organic Lead								X											
Pentachlorophenol					X						X								
Plutonium-239							X						X					X	
Potassium-40													X						
Radium-226							X						X					X	X
Selenium																			
Strontium-90							X						X					X	X
Tetrachloroethene	X		X	X				X		X	X					X			
Thallium					X			X			X								
Thorium-232													X					X	
Total Aroclors		X																	
Total DDT		X																	
Total HMW PAHs																			
Total PCBs (non-dioxin)																			
Total TPH																			
trans-1,2-Dichloroethene				X						X	X								
trans-1,3-Dichloropropene										X									
Trichloroethene	X		X	X	X			X		X	X					X			
Trichlorofluoromethane				X						X	X								
Uranium-235																		X	

Chemical	Parcel E						Parcel E-2						Parcel F		Parcel G				
	Soil	Sediment	Soil Gas[3]	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil, Human Health and Terrestrial Wildlife	Sediment	Soil Gas	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Sediment	Sediment, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Ecological	Soil and Structures, Radionuclides
Hexachlorobenzene																			
Hexachloroethane																			
Hydrogen-3																			X
Indeno(1,2,3-cd)pyrene	X						X			X									
Iron	X						X			X									
Isopropylbenzene																			
Lead	X	X					X	X		X					X				
Manganese	X			X			X								X				
Mercury	X	X					X	X					X						
Methylene Chloride										X							X		
Methoxychlor																			
Molybdenum		X																	
Naphthalene	X						X			X							X		
Nickel	X						X	X										X	
n-Nitroso-di-n-propylamine	X																		
n-Nitrosodiphenylamine	X																		
Organic Lead																			
Pentachlorophenol	X																		
Plutonium-239						X								X					X
Potassium-40																			
Radium-226						X						X		X					X
Selenium																			
Strontium-90						X						X		X					X
Tetrachloroethene				X						X						X	X		
Thallium	X			X						X									
Thorium-232																			X
Total Aroclors		X					X	X					X						
Total DDT		X					X	X											
Total HMW PAHs							X												
Total PCBs (non-dioxin)							X												
Total TPH	X				X		X				X								
trans-1,2-Dichloroethene				X															
trans-1,3-Dichloropropene																			
Trichloroethene	X			X						X						X	X		
Trichlorofluoromethane																			
Uranium-235						X								X					X

Chemical	Parcel UC-1			Parcel UC-2				Parcel UC-3			
	Soil	Soil Gas[2]	Soil and Structures, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Soil and Structures, Radionuclides	Soil	Soil Gas[2]	Groundwater	Soil and Structures, Radionuclides
Hexachlorobenzene											
Hexachloroethane											
Hydrogen-3			X								
Indeno(1,2,3-cd)pyrene								X			
Iron											
Isopropylbenzene											
Lead								X			
Manganese				X							
Mercury											
Methylene Chloride											
Methoxychlor											
Molybdenum											
Naphthalene											
Nickel											
n-Nitroso-di-n-propylamine											
n-Nitrosodiphenylamine											
Organic Lead											
Pentachlorophenol											
Plutonium-239			X								
Potassium-40											
Radium-226			X				X				X
Selenium											
Strontium-90			X				X				X
Tetrachloroethene											
Thallium											
Thorium-232			X								
Total Aroclors											
Total DDT											
Total HMW PAHs											
Total PCBs (non-dioxin)											
Total TPH											
trans-1,2-Dichloroethene											
trans-1,3-Dichloropropene											
Trichloroethene		X				X				X	
Trichlorofluoromethane											
Uranium-235			X								

Table 1. Chemicals of Concern and Contaminated Media *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

	Parcel												
	B (including IR-07/18 and B-1 and B-2)							C					
Chemical	Soil	Sediment	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[3]	Groundwater, Vapor Intrusion	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides
Vanadium	X							X					
Vinyl Chloride			X	X				X		X	X		
Xylene (total)													
Zinc	X	X						X				X	

	Parcel																	
	D-1					D-2	E						E-2					
Chemical	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil and Structures, Radionuclides	Soil	Sediment	Soil Gas[3]	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil, Human Health and Terrestrial Wildlife	Sediment	Soil Gas	Groundwater, Domestic Use	Groundwater, Ecological	Soil and Structures, Radionuclides
Vanadium							X						X					
Vinyl Chloride										X						X		
Xylene (total)			X				X											
Zinc							X	X					X					

	Parcel																	
	F		G					UC-1			UC-2				UC-3			
Chemical	Sediment	Sediment, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Groundwater, Ecological	Soil and Structures, Radionuclides	Soil	Soil Gas[2]	Soil and Structures, Radionuclides	Soil	Soil Gas[1]	Groundwater, Vapor Intrusion	Soil and Structures, Radionuclides	Soil	Soil Gas[2]	Groundwater	Soil and Structures, Radionuclides
Vanadium																		
Vinyl Chloride									X									
Xylene (total)					X													
Zinc																		

Notes:

1 = COCs in soil gas exceeding soil gas action levels in risk grids failing Tier 2 human health risk assessment (SES, 2013).

2 = COCs in soil gas exceeding soil gas action levels in risk grids failing Tier 1 human health risk assessment (SES, 2013).

3 = Soil gas investigation to identify COCs has not been completed to date.

BHC = benzene hexachloride
COCs = chemicals of concern
DDD = dichlorodiphenyldichloroethane
DDE = dichlorodiphenyldichloroethene
DDT = dichlorodiphenyltrichloroethane
HMW = high molecular weight
IR = Installation Restoration
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
SES = Sealaska Environmental Services LLC
TPH = total petroleum hydrocarbons

Table 2. Pre-ROD Response Actions for Parcel B (i.e., IR-07/18 and Parcels B-1 and B-2)
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
1994	SI	Site assessments were completed at Parcels B, C, D, and E and included field investigations at 75 sites. Further investigation was recommended for 28 of the 75 sites assessed. The PA/SI determined that the majority of the potential source areas required additional investigation (PRC, LFR, and Uribe and Associates, 1996a).
6/1996	RI	The RI involved further investigation of sites identified at Parcel B during the initial assessment (IR-06, IR-07, IR-10), Triple A investigation (IR-18, SI-45), the PA (SI-31, IR-20, IR-23, IR-24, IR-25, IR-26, IR-42, IR-46, IR-50, IR-51), and the SI (IR-60, IR-61, IR-62) (PRC, LFR, and Uribe and Associates, 1996a).
1996	FS	Results and analysis in the RI Report were used to identify, screen, and evaluate remedial alternatives and to define areas for proposed remedial action (PRC, 1996b).
1996	Removal Actions at IR-23, IR-26, and IR-50 (sediment in Parcel B storm drains)	About 1,700 cubic yards of soil was removed from five areas (EE-01 through EE-05) (IT Corporation, 1999a). Most of the excavated areas were expanded or deepened during subsequent remedial actions.
10/7/97	Original ROD	The selected remedy documented in the original ROD included excavation and offsite disposal of contaminated soil, long-term monitoring of groundwater, and institutional controls.
8/98	ESD (First)	The first ESD to the 1997 ROD revised the selected remedy to require excavation of contaminated soil to a 10^{-6} cancer risk or to a maximum depth of 10 feet bgs, instead of to groundwater as required by the 1997 ROD.
7/98–9/99	Remedial Action (Phase 1)	The first phase of the remedial action was started (construction mobilization) on July 8, 1998. This action was the trigger for the first five-year review. About 54,400 cubic yards of soil was removed from 84 areas and disposed of off site (ChaduxTt, 2008). COCs included metals, VOCs, PAHs, and PCBs. Many of the excavated areas were expanded in the second remedial action phase in 2000 to 2001.
5/2000	ESD (Second)	The second ESD to the 1997 ROD updated the RGs for soil based on revised risk assessment methods and site-specific data. The second ESD resulted in an amendment to the RD.
5/2000–12/2001	Remedial Action (Phase 2)	During the second phase of the remedial action, about 47,200 cubic yards of soil was removed from 43 areas and disposed of off site (ChaduxTt, 2008). COCs for the second phase were primarily metals. The Navy met the cleanup requirements of the ROD (Navy, 1997) and subsequent ESDs (Navy, 1998 and 2000) at most of the excavation sites. However, the ubiquitous distribution of metals, especially arsenic and manganese, led to the reevaluation of the remedy for soil.

Table 2. Pre-ROD Response Actions for Parcel B (i.e., IR-07/18 and Parcels B-1 and B-2) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
2001	Quarterly Groundwater Monitoring	Quarterly groundwater monitoring results indicate chemical concentrations in groundwater and the extent of those chemicals in groundwater is greater than initially considered in the ROD.
6/2000–9/2002	SVE Treatability Study at IR-10	This study showed the initial effectiveness of SVE to treat soil vapor at IR-10 (IT Corporation 2002a; TtEMI, 2003e).
2003	Investigation of Chromium VI in IR-10 Groundwater	Investigated the extent of chromium VI around well IR10MW12A. This investigation supported characterization of chromium VI in groundwater.
2004	HRA	The HRA designated sites as impacted or non-impacted with respect to radiological contamination. Phase V investigations and surveys were completed at Buildings 103, 113, 130, and 146 and Dry Dock 6. Details of these activities are included in Sections 6 and 8 and Table 6-6 of the HRA (NAVSEA, 2004).
2003–2004	Waste Consolidation and Removal Activities	Basewide actions to address aboveground issues identified previously at and near buildings, including removal of waste material; decontamination or removal of equipment and structures; and abatement of friable, accessible, and damaged asbestos-containing materials. The primary objective of this action was to address potential environmental issues associated with the industrial use of buildings that could affect the planned transfer of the property to the City and County of San Francisco (Tetra Tech FW, Inc., 2004b).
5/2003–6/2003	Characterization and Sampling of Shoreline at IR-07 and IR-26	Samples collected during this investigation provided the basis for the evaluation of potential risk to aquatic receptors, which contributed to the subsequent selection of shoreline revetment as part of the amended remedy (TtEMI and ITSI, 2004a).
9/2003–3/2004	Groundwater Treatability Study at IR-10	Groundwater treatability study at IR-10 using injection of ZVI (ERRG and URS, 2004). This study showed the effectiveness of ZVI in treating VOCs in groundwater at IR-10 and resulted in large concentration reductions.
2005	Soil Gas Survey at IR-07/18	Soil gas survey for evaluation of methane and total VOCs to assess nature and extent of concentrations in soil gas at IR-07/18. The soil gas survey established the presence of methane at IR-07.
2006	Phase III SVE Treatability Study at IR-10	Expanded the treatability study at IR-10 to evaluate SVE for removal of TCE and other VOCs from soil beneath Building 123. The treatability study was the basis for use of SVE in revised remedial alternatives.

Table 2. Pre-ROD Response Actions for Parcel B (i.e., IR-07/18 and Parcels B-1 and B-2) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
12/2007	TMSRA	The TMSRA evaluated site-specific information about Parcel B that became available after signature of the 1997 ROD. The updated information was obtained from (1) the original remedial action (Phases 1 and 2) for soil conducted between 1998 and 2001, (2) groundwater monitoring conducted since 1999, and (3) the HRA and subsequent radiological removal actions.
5/2006–9/2010	Radiological Removal Actions	Radiological removal actions were completed at Parcel B, during which 24,826 linear feet of trench and 69,984 cubic yards of soil were excavated; approximately 3,217 cubic yards of soil was disposed of off site as low-level radioactive waste (TtEC, 2012a and 2012c).
8/2008–10/2008	TCRA for Methane at IR-07	Excavation and offsite disposal of about 17,000 cubic yards of soil from IR-07 to remove a methane source area. The TCRA found that debris was confined to a layer extending from about 2 to 8 feet bgs that was above the water table, which was at about 18 feet bgs at the excavation site. Material below 8 feet bgs was predominantly clean engineered fill without debris or staining. A layer of material at the top of the Bay Mud at about 23 to 25 feet bgs was observed to be highly organic and odiferous. Excavation continued into the native Bay Mud to a depth of about 27 feet bgs to remove the organic layer. The Navy concluded the organic layer was the likely source of methane and debris used as fill located above the water table was not a likely source of methane (SES-TECH, 2009).
9/2008–10/2008	TCRA for Mercury at IR-26	Excavation and offsite disposal of about 6,000 cubic yards of soil from IR-26 to remove a mercury source area. In total, 98 soil and 19 groundwater samples were collected from 21 borings advanced to the underlying bedrock to delineate mercury source areas. Three excavations to bedrock, ranging from 13 to 18 feet bgs, were completed. Excavations were backfilled with controlled density fill to the water table elevation and then with drain rock and clean soil to surface grade (Insight, 2009).
1/26/2009	Amended ROD	The Amended ROD documents the changes to the selected remedy based on the evaluations in the TMSRA. The significant changes to the selected remedy include (1) modification of the soil remedy to include durable covers to address soil contamination, (2) addition of active treatment methods to the groundwater remedy, (3) consideration of potential ecological risks to aquatic receptors, and (4) inclusion of methods and RGs to address radiological contamination.

Table 2. Pre-ROD Response Actions for Parcel B (i.e., IR-07/18 and Parcels B-1 and B-2) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Notes:

1 = The documents listed are available in the Navy's Administrative Record and provide detailed information used to support remedy selection at Parcel B (including IR-07/18 and Parcels B-1 and B-2). Note that at the time of remedy selection, Parcel B had not been subdivided into Parcels B-1 and B-2; separate remedies were selected for IR-07 and IR-18 (excluding the remainder of the former Parcel B) and for the remainder of the former Parcel B (i.e., Parcels B-1 and B-2).

ASTs = aboveground storage tanks
bgs = below ground surface
COCs = chemicals of concern
EE = exploratory excavation
ERRG = Engineering/Remediation Resources Group, Inc.
ESD = Explanation of Significant Differences
FS = Feasibility Study
HRA = Historical Radiological Assessment
Insight = Insight Environmental, Engineering, and Construction, Inc.
IR = Installation Restoration
ITSI = Innovative Technical Solutions, Inc.
ISB = in-situ bioremediation
LFR = Levine Fricke Recon
NAVSEA = Naval Sea Systems Command
Navy = Department of the Navy
PA/SI = Preliminary Assessment/Site Inspection
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
PRC = PRC Environmental Management, Inc.
RGs = remediation goals
RI = Remedial Investigation
ROD = Record of Decision
SES-TECH = SES-TECH Remediation Services, Inc.
SVE = soil vapor extraction
TCE = trichloroethene
TCRA = time-critical removal action
TMSRA = Technical Memorandum in Support of a ROD Amendment
TtEC = Tetra Tech EC, Inc.
TtEMI = Tetra Tech EM Inc.
URS = URS Corporation
USTs = underground storage tanks
VOCs = volatile organic compounds
ZVI = zero-valent iron

Table 3. RAOs and Remedy Components for Parcel B (i.e., IR-07/18 and Parcels B-1 and B-2)
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Soil, Sediment, and Soil Gas		
Prevent exposure to organic and inorganic chemicals in soil at concentrations above remediation goals developed in the human health risk assessment for the following exposure pathways: ▪ Ingestion of, outdoor inhalation of, and dermal exposure to soil ▪ Ingestion of homegrown produce by residents in research and development and mixed-use reuse areas	▪ Excavation and offsite disposal of soil in select areas where COCs exceed remediation goals	▪ Durable covers ▪ Monitoring, maintenance, and ICs
Prevent exposure to VOCs in soil gas at concentrations that would pose unacceptable risk (i.e., risk greater than 10^{-6}) via indoor inhalation of vapors.	▪ Removal and treatment of vapors in soil gas using SVE at IR-10	▪ Soil gas surveys ▪ Monitoring, maintenance, and ICs
Reduce presence of methane in soil gas such that concentrations do not accumulate and become explosive in structures.[1]	▪ Excavation of soil in IR-07 to remove a methane source	▪ Methane monitoring and ICs
Prevent or minimize exposure of ecological receptors to organic and inorganic chemicals in soil and sediment in shoreline areas at concentrations above remediation goals established for sediment.	▪ Excavation of sediment and debris to permit revetment construction	▪ Durable covers ▪ Monitoring and maintenance
Groundwater		
Prevent exposure to VOCs and mercury in A-aquifer groundwater at concentrations above remediation goals via indoor inhalation of vapors from groundwater. *This RAO for exposure to vapors from groundwater via vapor intrusion has been superseded by action levels established for soil vapor (ChaduxTt, 2011g; SES, 2013).*	▪ In-situ groundwater treatment using biological substrate injections to address VOCs at IR-10	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs

Table 3. RAOs and Remedy Components for Parcel B (i.e., IR-07/18 and Parcels B-1 and B-2) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Groundwater *(continued)*		
Prevent direct exposure to B-aquifer groundwater at concentrations above remediation goals through the domestic use pathway (for example, drinking water or showering).	▪ None	▪ Monitoring (MNA) and ICs
Prevent or minimize exposure of construction workers to metals, VOCs, and SVOCs in A-aquifer groundwater at concentrations above remediation goals from dermal exposure and inhalation of vapors from groundwater.	▪ In-situ groundwater treatment using biological substrate injections to address VOCs at IR-10	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs
Prevent or minimize migration to surface water of San Francisco Bay of chromium VI, copper, lead, and mercury in A-aquifer groundwater that would result in concentrations of chromium VI above 50 µg/L, copper above 28.04 µg/L, lead above 14.44 µg/L, and mercury above 0.6 µg/L in the surface waters of San Francisco Bay. This RAO is intended to protect the beneficial uses of the bay, including ecological receptors.	▪ None	▪ Monitoring (MNA)
Radiologically Impacted Soil and Structures		
Prevent exposure to radionuclides of concern at concentrations that exceed remediation goals for the ingestion or inhalation exposure pathways.	▪ Radiological surface scan and removal of anomalies at IR-07/18 ▪ Radiological surveys and remediation	▪ Durable covers[2] ▪ Monitoring, maintenance, and ICs[2]

Notes:

1 = This RAO applies to IR-07/18 only; it does not apply to Parcels B-1 and B-2 because methane is not present in soil gas within these parcels.

2 = These components of the radiological remedy apply to portions of IR-07/18 only (i.e., within the area requiring ICs for radionuclides). Durable covers and ICs to address radiological contaminants are not required for the remaining areas of IR-07/18 and Parcels B-1 and B-2, where radiological surveys and remediation adequately address radiological contamination.

COCs = chemicals of concern
ICs = institutional controls
IR = Installation Restoration
MNA = monitored natural attenuation
RAOs = remedial action objectives
SES = Sealaska Environmental Services LLC
SVE = soil vapor extraction
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds
µg/L = micrograms per liter

Table 4. Pre-ROD Response Actions for Parcel C (i.e., Parcels C and UC-2)
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
1994	SI	Site assessments were completed at Parcels B, C, D, and E and included field investigations at 75 sites. Further investigation was recommended for 28 of the 75 sites assessed. The PA/SI determined that the majority of the potential source areas required additional investigation (PRC, LFR, and Uribe and Associates, 1996a).
3/1997	RI	The RI included collection of 1,173 soil samples, 570 groundwater samples, and 129 source samples. Based on the RI results, 12 sites in former Parcel C (plus IR-06 and IR-25) were recommended for further evaluation in an FS.
1996–1997	Exploratory Excavation Removal Action	About 800 cubic yards of soil removed from six exploratory excavation areas (EE-06 through EE-11) (IT Corporation, 1999a).
1996–1997	Storm Drain Sediment Removal	As part of a base-wide removal action, sediment was removed from storm drain lines at Parcels C and UC-2. Sediment in drainage culverts at Dry Dock 4 was partially removed.
1996–1998	FS (initial phase)	Results and analysis in the RI Report were used to identify, screen, and evaluate remedial alternatives and to define areas for proposed remedial action.
7/98–9/99	Soil Removals at IR-06 and IR-25	Contaminated soil was removed from IR-06 and IR-25 during the initial remedial action at former Parcel B before these areas were moved to Parcel C (IT Corporation, 2000). Removed soil was disposed of off site, and the excavations were backfilled with clean material.
1999	RMR	The RMR process used various criteria and decision rules to reevaluate whether remedial actions were required at all of the 14 IR sites in former Parcel C that had been originally identified as requiring remedial actions for soil. Of the 14 IR sites in former Parcel C, six were recommended for action after the RMR process. Based on the RMR results, the sites and chemicals requiring further evaluation and remedial action were revised.
4/2001	Groundwater Treatability Study at Building 253	Treatability study for groundwater at Building 253 using chemical oxidation by potassium permanganate injection (TtEMI, 2004b).
2000–2002	Fuel and Steam Line TCRA	All subsurface fuel lines and contaminated steam lines were removed during a TCRA. About 8,800 cubic yards of soil was also removed and disposed of off site (TtEMI, 2002).
2001–2002	SVE Treatability Studies	Treatability studies were completed for SVE at Buildings 134, 211/253, 231, 251, and 272 (IT Corporation, 2001, 2002b, 2002c, 2002d, and 2002e).
9/2002	Groundwater Treatability Study at Building 272	Treatability study for groundwater using ZVI injection completed at Building 272 (TtEMI, 2003c).

Table 4. Pre-ROD Response Actions for Parcel C (i.e., Parcels C and UC-2) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
2002–2004	Waste Consolidation and Removal Activities	Industrial process equipment was decontaminated, sumps were cleaned, and waste was consolidated for offsite disposal, including waste materials stored in or near buildings and removal or encapsulation of asbestos-containing materials (Tetra Tech FW, Inc., 2004b).
2003	Encapsulation of Drainage Culvert Sediment at Dry Dock 4	Contaminated sediment in two culverts under Dry Dock 4 was encapsulated (TtEMI, 2003a).
2004	Degreaser Pit/Separator Demolition at RU-C5	A degreaser pit and oil-water separator were removed at Building 134.
2004	HRA	The HRA evaluated and designated sites as radiologically impacted or non-impacted. Based on the HRA results, nine sites along with the sanitary sewer and storm drain lines, at Parcel C were determined to have the potential for radiological contamination and require further investigation (NAVSEA, 2004).
4/2004–5/2005	Groundwater Treatability Study at Building 134	Treatability study for groundwater was conducted at Building 134 using in-situ sequential anaerobic-aerobic bioremediation (Shaw, 2005).
8/2004–1/2005	Follow-on Groundwater Treatability Study at Building 272	Follow-on treatability study for groundwater at Building 272 using ZVI injection (ITSI, 2005).
7/2008	Revised FS	Existing RI data were combined with new data obtained after completion of the 1996 (Parcel B, IR-06, and IR-25) and 1997 (former Parcel C) RI Reports. The revised FS considered new information associated with several response actions completed within former Parcel C and at other adjacent parcels. New information included (1) quarterly monitoring of groundwater, (2) updates to toxicity criteria used in the 1997 HHRA, and (3) the findings from removal actions conducted to address chemicals identified during the RMR process and radiological contaminants that were identified in the HRA.
6/2009–6/2010	Groundwater Treatability Study at Building 253	Treatability study for groundwater at Building 253 using anaerobic bioremediation through injection of sodium lactate and emulsified vegetable oil (OTIE, 2011).
5/2010–4/2011	Groundwater Treatability Study at Building 134	Treatability study for groundwater using ZVI injection at Building 134 (CDM Smith, 2012).
9/2010	ROD	The selected remedy documented in the ROD included excavation and offsite disposal of contaminated soil, radiological remediation of soil and structures, soil gas treatment using SVE, durable covers, groundwater treatment with ZVI or ISB, MNA, and institutional controls.

Table 4. Pre-ROD Response Actions for Parcel C (i.e., Parcels C and UC-2) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Notes:

1 = The documents listed are available in the Administrative Record and provide detailed information used to support remedy selection at Parcels C and UC-2.

AST = aboveground storage tank
Battelle = Battelle Memorial Institute
EE = exploratory excavation
FS = Feasibility Study
HHRA = human health risk assessment
HRA = Historical Radiological Assessment
IR = Installation Restoration
ISTI = Innovative Technical Solutions, Inc.
ISB = in-situ bioremediation
LFR = Levine Frick Recon
MNA = monitored natural attenuation
NAVSEA = Naval Sea Systems Command
Navy = Department of the Navy
OTIE = Oneida Total Integrated Enterprises, Inc.
PRC = PRC Environmental Management, Inc.
RI = Remedial Investigation
RMR = risk management review
RU = Remedial Unit
Shaw = Shaw Environmental, Inc.
SVE = soil vapor extraction
TCRA = time-critical removal action
TtEMI = Tetra Tech EM Inc.
UST = underground storage tank
ZVI = zero-valent iron

Table 5. RAOs and Remedy Components for Parcel C
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Soil and Soil Gas		
Prevent or minimize exposure to organic and inorganic chemicals in soil at concentrations above remediation goals developed in the human health risk assessment for the following exposure pathways: ▪ Ingestion of, outdoor inhalation of, and dermal exposure to surface and subsurface soil ▪ Ingestion of homegrown produce in native soil	▪ Excavation and offsite disposal of soil in select areas where COCs exceed remediation goals	▪ Durable covers ▪ Monitoring, maintenance, and ICs
Prevent or minimize exposure to VOCs in soil gas at concentrations that would pose unacceptable risk via indoor inhalation of vapors. Table 7 of the final soil gas memorandum lists the volatile chemicals (ChaduxTt, 2010b). This list includes SVOCs (such as pesticides and PAHs). Remediation goals for VOCs to address exposure via indoor inhalation of vapors may be superseded based on COC identification information from future soil gas surveys. Future action levels would be established for soil gas, would account for vapors from both soil and groundwater, and would be calculated based on a cumulative risk level of 10^{-6} using the accepted methodology for risk assessments at HPNS.	▪ In-situ soil treatment using SVE at eight areas	▪ Soil gas surveys ▪ Monitoring, maintenance, and ICs
Groundwater		
Prevent or minimize exposure to VOCs in A-aquifer groundwater at concentrations above remediation goals via indoor inhalation of vapors from groundwater. *This RAO for exposure to vapors from groundwater via vapor intrusion has been superseded by action levels established for soil vapor (ChaduxTt, 2011g; SES, 2013).*	▪ In-situ groundwater treatment using ZVI or biological substrate injections at RU-C1, RU-C2, RU-C4, and RU-C5	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs

Table 5. RAOs and Remedy Components for Parcel C *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Groundwater *(continued)*		
Prevent or minimize direct exposure to groundwater that may contain COCs through the domestic use pathway in the B-aquifer, RU-C5 only (for example, drinking water or showering).	▪ In-situ groundwater treatment using ZVI or biological substrate injections at RU-C5	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs
Prevent or minimize exposure of construction workers to metals and VOCs in A-aquifer groundwater at concentrations above remediation goals from dermal exposure and inhalation of vapors from groundwater.	▪ In-situ groundwater treatment using ZVI or biological substrate injections at RU-C1, RU-C2, RU-C4, and RU-C5	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs
Prevent or minimize migration to surface water of San Francisco Bay of chromium VI and zinc in A-aquifer groundwater that would result in concentrations of chromium VI above 50 µg/L and nickel above 81 µg/L at the point of discharge to the bay.	▪ In-situ groundwater treatment using ZVI or biological substrate injections at RU-C1, RU-C2, RU-C4, and RU-C5	▪ Monitoring (MNA) and ICs
Radiologically Impacted Soil and Structures		
Prevent or minimize exposure to ROCs in concentrations that exceed remediation goals for all potentially complete exposure pathways (e.g., external radiation, soil ingestion, and inhalation of resuspended radionuclides in soil or dust).	▪ Radiological surveys and remediation	▪ None

Notes:
COCs = chemicals of concern
HPNS = Hunters Point Naval Shipyard
ICs = institutional controls
MNA = monitored natural attenuation
PAHs = polycyclic aromatic hydrocarbons
RAOs = remedial action objectives
ROCs = radionuclides of concern
RU = remedial unit
SES = Sealaska Environmental Services LLC
SVE = soil vapor extraction
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds
ZVI = zero-valent iron
µg/L = micrograms per liter

Table 6. RAOs and Remedy Components for Parcel UC-2
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Soil and Soil Gas		
Prevent or minimize exposure to inorganic chemicals in soil at concentrations above remediation goals developed in the human health risk assessment for the following exposure pathways: ▪ Ingestion of, outdoor inhalation of, and dermal exposure to surface and subsurface soil ▪ Ingestion of homegrown produce by residents in mixed-use and research and development blocks	▪ None	▪ Durable covers ▪ Monitoring, maintenance, and ICs
Prevent or minimize exposure to VOCs in soil gas at concentrations that would pose unacceptable risk via indoor inhalation of vapors. Remediation goals for VOCs to address exposure via indoor inhalation of vapors have been superseded based on COC identification information from soil gas surveys. Action levels have been established for soil gas that account for vapors from both soil and groundwater and were calculated based on a cumulative risk level of 10^{-6} using the accepted methodology for risk assessments at HPNS (ChaduxTt, 2011g; SES, 2013).	▪ None	▪ Soil gas surveys ▪ Monitoring and ICs
Groundwater		
Prevent or minimize exposure to VOCs in A-aquifer groundwater at concentrations above remediation goals via indoor inhalation of vapors from groundwater. *This RAO for exposure to vapors from groundwater via vapor intrusion has been superseded by action levels established for soil vapor (ChaduxTt, 2011g; SES, 2013).*	▪ MNA at IR-06	▪ Soil gas surveys ▪ Monitoring and ICs
Prevent or minimize direct exposure to groundwater that may contain COCs through the domestic use pathway (e.g., drinking water or showering).	▪ MNA at IR-06	▪ Monitoring and ICs

Table 6. RAOs and Remedy Components for Parcel UC-2 *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Groundwater *(continued)*		
Prevent or minimize exposure of construction workers to VOCs in A-aquifer groundwater at concentrations above remediation goals from dermal exposure and inhalation of vapors from groundwater.	▪ MNA at IR-06	▪ Soil gas surveys ▪ Monitoring and ICs
Radiologically Impacted Soil and Structures		
Prevent exposure to ROCs in concentrations that exceed remediation goals for all potentially complete exposure pathways (e.g., external radiation, soil ingestion, and inhalation of resuspended radionuclides in soil or dust).	▪ Radiological Surveys and Remediation	▪ None

Notes:
COCs = chemicals of concern
ICs = institutional controls
IR = Installation Restoration
MNA = monitored natural attenuation
RAOs = remedial action objectives
ROCs = radionuclides of concern
SES = Sealaska Environmental Services LLC
VOCs = volatile organic compounds

Table 7. Pre-ROD Response Actions for Parcel D (i.e., Parcels D-1, D-2, G, and UC-1)
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
1994	SI	Site assessments were completed at Parcels B, C, D, and E and included field investigations at 75 sites. Further investigation was recommended for 28 of the 75 sites assessed. The PA/SI determined that the majority of the potential source areas required additional investigation (PRC, LFR, and Uribe and Associates, 1996a).
1988–1997	RI	Site conditions were assessed through literature searches; interviews with former onsite employees; geophysical, radiological, and aerial map surveys; installation of soil borings and monitoring wells, and aquifer testing. The following environmental samples were collected: 418 surface soil, 1,938 subsurface soil, 429 A-aquifer groundwater samples, 9 B-aquifer groundwater samples, 7 bedrock water-bearing zone groundwater samples, 185 HydroPunch groundwater samples, 77 water and sediment samples (from utility lines, sumps, and floor drains), 8 sandblast samples, 1 asbestos sample, 29 test pit samples, 2 floor scrape samples, and 2 UST samples. Based on the RI results, all of Parcel D (except for IR-48 and IR-66) was recommended for further evaluation in an FS.
1989	PCB-Contaminated Soil Removal at IR-08	About 1,255 cubic yards of soil contaminated by PCBs removed at IR-08 (ERM-West, 1989).
1991–1993	UST and AST removals	Nine USTs were removed and one was closed in place; three ASTs were removed.
1991–1995	Removal of Sandblast Waste	Sandblast waste was collected and removed basewide (Battelle, 1996).
1994–1996	Contaminated Equipment and Residue Removed from IR-09	Contaminated equipment and residue was removed from IR-09 (pickling and plating yard). Approximately 200,000 pounds of hazardous waste liquids, 1,500 cubic yards of hazardous waste solids, 100,000 of nonhazardous waste liquids, and 350,000 pounds of scrap metal were removed and disposed of off site (SulTech, 2007b).
1996	Removal of Cesium-Impacted Soil	Approximately 1 cubic yard of soil affected by a cesium-137 spill was removed from an area behind Building 364.
1996–1997	Exploratory Excavation Removal Action	Stained soil, asphalt, and concrete were removed from two IR sites (IR-53 and IR-70) within Parcel D-1 and three IR sites (IR-33, IR-37, and IR-70) within Parcel G.
1996–1997	Removal of Storm Drain Sediment	In total, 1,200 tons of contaminated sediment was removed from storm drain lines and appurtenances in Parcel D.
1996–1997	FS	Results and analyses in the RI Report were used to identify, screen, and evaluate remedial alternatives and to define areas for proposed remedial action.

Table 7. Pre-ROD Response Actions for Parcel D (i.e., Parcels D-1, D-2, G, and UC-1) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
1999	RMR	The RMR process used various criteria and decision rules to reevaluate whether remedial actions were required at 19 of the 27 IR sites in Parcel D that had been originally identified as requiring remedial actions for soil. Based on the RMR results, the sites and chemicals requiring further evaluation and remedial action were revised.
2001	TCRA for Non-VOCs in Soil	About 63 cubic yards of soil was removed from IR-08, IR-09, IR-37, IR-53, IR-55, and IR-65. Steam lines saturated with oil were removed; other steam lines were pressure-tested, cleaned, and left in place. About 150 feet of fuel line was also removed (TtEMI and IT Corporation, 2001).
2001–2002	Radiological TCRA	Approximately 15 cubic yards of soil affected by a cesium-137 spill was removed from IR-33 South.
2002	Groundwater Data Gaps Investigation	A data gaps investigation was completed to provide additional understanding of the groundwater conditions underlying the parcel. Groundwater samples were collected and analyzed for various chemicals (including metals and VOCs), and results were used to further define the nature and extent of contamination in groundwater.
4/2002–6/2003	Waste Consolidation and Removal Activities	Decontamination and waste consolidation activities were conducted, including encapsulating or removing asbestos-containing material; removing and disposing of structural materials, paint booths, and numerous abandoned waste items; removing and disposing of hoods, vents, and ducts associated with industrial processes; removing or disabling existing ASTs; and cleaning industrial process-related sumps, vaults, trenches, and equipment foundations (Foster Wheeler Environmental Corporation, 2003).
2003–2004	Soil Stockpile Removal Action	Navy inventoried all the stockpiles at HPNS. Nine soil and waste asphalt stockpiles were removed (TtEMI and ITSI, 2005).
2004	HRA	The HRA evaluated and designated sites as radiologically impacted or non-impacted. Based on the HRA results, one building, four building sites, the gun mole pier, and the sanitary sewer and storm drain lines were identified as radiologically impacted at Parcel D-1; one building and the sanitary sewer and storm drain lines were identified as impacted at Parcel UC-1; and six buildings, one building site, and the sewer and storm drains were identified as radiologically impacted at Parcel G (NAVSEA, 2004).
2006–2011	Storm Drain and Sanitary Sewer Removal Actions	Radiological removal actions, including radiological investigation and removal of storm drains and sanitary sewers, were completed throughout Parcels D-1, D-2, G, and UC-1.

Table 7. Pre-ROD Response Actions for Parcel D (i.e., Parcels D-1, D-2, G, and UC-1) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
2007	Revised FS	Existing RI data were combined with new data collected after completion of the 1996 RI Report. The revised FS considered new information associated with several response actions completed within Parcel D and at other adjacent parcels at HPNS. New information included (1) the widespread presence of metals in soil across Parcel D, (2) quarterly monitoring of groundwater since 2004, (3) updates to toxicity criteria used in the 1997 HHRA, and (4) the findings from removal actions conducted to address chemicals identified by a RMR process and radiological contaminants that were identified by the HRA.
10/2008–4/2009	Treatability Study for Groundwater at Parcels D-1 and G	Treatability study for groundwater at Parcels D-1 and G using ZVI injections (Alliance, 2010). This study showed the effectiveness of ZVI in treating VOCs in groundwater at Parcels D-1 and G and resulted in large reductions in VOC concentrations. All VOC concentrations in groundwater at Parcel D-1 remain below remediation goals established in the ROD.
2/2009	ROD for Parcel G	The selected remedy documented in the ROD included excavation and offsite disposal of contaminated soil, radiological remediation of soil and structures, durable covers, groundwater treatment with ZVI or ISB, groundwater monitoring, and institutional controls.
7/2009	ROD for Parcels D-1 and UC-1	The selected remedy documented in the ROD included excavation and offsite disposal of contaminated soil, radiological remediation of soil and structures, durable covers, groundwater treatment with ZVI or ISB, groundwater monitoring, and institutional controls.
8/2010	NFA ROD for Parcel D-2	The ROD documented that no further action was necessary to ensure protection of human health or the environment.

Notes:

1 = The documents listed are available in the Administrative Record and provide detailed information used to support remedy selection at Parcels D-1, G, and UC-1, as well as the No Further Action determination at Parcel D-2.

Alliance = The Alliance Compliance Group Joint Venture
ASTs = aboveground storage tanks
Battelle = Battelle Memorial Institute
ERM-West = Environmental Resources Management-West, Inc.
FS = Feasibility Study
HHRA = human health risk assessment
HPNS = Hunters Point Naval Shipyard
HRA = Historical Radiological Assessment
IR = Installation Restoration
ISB = in-situ bioremediation
ITSI = Innovative Technical Solutions, Inc.
LFR = Levine Fricke Recon
NAVSEA = Naval Sea Systems Command
Navy = Department of the Navy
NFA = no further action
PCBs = polychlorinated biphenyls
PRC = PRC Environmental Management, Inc.
RI = remedial investigation
RMR = risk management review
ROD = Record of Decision
TCRA = time-critical removal action
TtEMI = Tetra Tech EM Inc.
USTs = underground storage tanks
VOCs = volatile organic compounds
ZVI = zero-valent iron

Table 8. RAOs and Remedy Components for Parcels D-1 and UC-1
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Soil and Soil Gas		
Prevent exposure to metals and PAHs in soil at concentrations above remediation goals developed in the human health risk assessment for the following exposure pathways: ▪ Ingestion of, outdoor inhalation of, and dermal exposure to surface and subsurface soil by industrial workers or construction workers	▪ Excavation and offsite disposal of soil in select areas where COCs exceed remediation goals[1] ▪ Removal and offsite disposal of select soil stockpiles[1]	▪ Durable covers ▪ Monitoring, maintenance, and ICs
Prevent exposure to VOCs in soil gas at concentrations that would pose unacceptable risk via indoor inhalation of vapors. Remediation goals for VOCs to address exposure via indoor inhalation of vapors may be superseded based on COC identification information from future soil gas surveys. Future action levels would be established for soil gas, would account for vapors from both soil and groundwater, and would be calculated based on a cumulative risk level of 10^{-6} using the accepted methodology for risk assessments at HPNS (ChaduxTt, 2011g; SES, 2013).	▪ None	▪ Soil gas surveys ▪ Monitoring and ICs
Groundwater		
Prevent exposure by industrial workers to VOCs in the A-aquifer groundwater at concentrations above remediation goals via indoor inhalation of vapors from groundwater. *This RAO for exposure to vapors from groundwater via vapor intrusion has been superseded by action levels established for soil vapor (ChaduxTt, 2011g; SES, 2013).*	▪ In-situ groundwater treatment using ZVI injections at IR-71[2]	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs
Prevent or minimize exposure of construction workers to metals and VOCs in A-aquifer groundwater at concentrations above remediation goals from dermal exposure and inhalation of vapors from groundwater.	▪ In-situ groundwater treatment using ZVI injections at IR-71[2]	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs

Table 8. RAOs and Remedy Components for Parcels D-1 and UC-1 *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Radiologically Impacted Soil and Structures		
Prevent exposure to ROCs in concentrations that exceed remediation goals for all potentially complete exposure pathways.	▪ Radiological surveys and remediation	▪ None

Notes:

1 = This component of the selected remedy for soil only applies to Parcel D-1.

2 = This component of the selected remedy for groundwater only applies to Parcel D-1.

COCs = chemicals of concern

HPNS = Hunters Point Naval Shipyard

ICs = institutional controls

IR = Installation Restoration

MNA = monitored natural attenuation

PAHs = polycyclic aromatic hydrocarbons

RAO = remedial action objective

ROCs = radionuclides of concern

SES = Sealaska Environmental Services LLC

VOCs = volatile organic compounds

ZVI = zero-valent iron

Table 9. RAOs and Remedy Components for Parcel G
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Soil and Soil Gas		
Prevent exposure to organic and inorganic chemicals in soil at concentrations above remediation goals developed in the HHRA for the following exposure pathways: ▪ Ingestion of, outdoor inhalation of, and dermal exposure to surface and subsurface soil ▪ Ingestion of homegrown produce by residents in mixed-use blocks	▪ Excavation and offsite disposal of soil in select areas where COCs exceed remediation goals ▪ Removal and offsite disposal of select soil stockpiles	▪ Durable covers ▪ Monitoring, maintenance, and ICs
Prevent exposure to VOCs in soil gas at concentrations that would pose unacceptable risk via indoor inhalation of vapors. Remediation goals for VOCs to address exposure via indoor inhalation of vapors have been superseded based on COC identification information from soil gas surveys. Future action levels would be established for soil gas, would account for vapors from both soil and groundwater, and would be calculated based on a cumulative risk level of 10^{-6} using the accepted methodology for risk assessments at HPNS (ChaduxTt, 2011g; SES, 2013).	▪ None	▪ Soil gas surveys ▪ Monitoring and ICs
Groundwater		
Prevent exposure to VOCs in A-aquifer groundwater at concentrations above remediation goals via indoor inhalation of vapors from groundwater. *This RAO for exposure to vapors from groundwater via vapor intrusion has been superseded by action levels established for soil vapor (ChaduxTt, 2011g; SES, 2013).*	▪ In-situ groundwater treatment using ZVI injections at IR-09, IR-33, and IR-71	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs
Prevent direct exposure to groundwater that may contain COCs through the domestic use pathway (e.g., drinking water or showering).	▪ No treatment required	▪ Monitoring (MNA) and ICs

Table 9. RAOs and Remedy Components for Parcel G *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Groundwater *(continued)*		
Prevent or minimize exposure of construction workers to metals and VOCs in A-aquifer groundwater at concentrations above remediation goals from dermal exposure and inhalation of vapors from groundwater.	▪ In-situ groundwater treatment using ZVI injections at IR-09, IR-33, and IR-71	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs
Prevent or minimize migration to surface water of San Francisco Bay of chromium VI and nickel in A-aquifer groundwater that would result in concentrations of chromium VI above 50 µg/L and nickel above 96.5 µg/L at the point of discharge to the bay.	▪ No treatment required	▪ Soil gas surveys ▪ Monitoring (MNA) and ICs
Radiologically Impacted Soil and Structures		
Prevent exposure to ROCs in concentrations that exceed remediation goals for all potentially complete exposure pathways.	▪ Radiological surveys and remediation	▪ None

Notes:
COCs = chemicals of concern
HHRA = human health risk assessment
HPNS = Hunters Point Naval Shipyard
ICs = institutional controls
IR = Installation Restoration
MNA = monitored natural attenuation
RAO = remedial action objective
ROCs = radionuclides of concern
SES = Sealaska Environmental Services LLC
VOCs = volatile organic compounds
ZVI = zero-valent iron
µg/L = micrograms per liter

Table 10. Pre-ROD Response Actions for Parcel E (i.e., Parcels E, E-2, and UC-3)
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
1988–1989	Solid Waste Air Quality Assessment Test	The study included evaluation of meteorological conditions, ambient air quality, landfill gas compositions, surface gas emissions, and subsurface gas migration. Methane was detected in isolated pockets at IR-01/21 and at the northern edge of the IR-01/21 boundary (HLA, 1989).
1988	OU RI Phase 1 Reconnaissance	Evaluated hydrogeologic conditions and identified waste boundaries using ground-penetrating radar, electromagnetic survey, and test pits to delineate the extent of waste depositions in fill material. Results were used to identify data needs for subsequent RI activities.
1988–1992	OU-1 RI	The Parcel E-2 Landfill progressed to the RI stage as IR-01/21 and was grouped (along with IR-02 and IR-03 in Parcel E) into OU-I. The first phase of the OU-I RI (from 1988 to 1989) included a geophysical survey and test pit excavation to delineate the extent of landfill waste, a soil gas survey to evaluate the presence of VOCs in soil and groundwater, and installation of deep soil borings to define subsurface stratigraphy. Subsequent investigation phases involved sampling of soil and groundwater (performed from 1990 to 1992).
1989	Removal of Soil at IR-08 PCB Spill Area	About 1,255 cubic yards of soil contaminated by PCBs was excavated from a PCB spill area, which underlies the southeast portion of Building 606 (ERM-West, 1989).
1991	Removal of Floating Product at IR-03	About 25 gallons of floating petroleum product on the water table and 70 gallons of subsurface waste oil were recovered by pumping and offsite disposal (HLA, 1991).
1991–1992	Intertidal Sediment Study	Sediment samples were collected in the intertidal zone, and the resulting data were used to identify COPECs in the Phase 1A ERA.
1993	Phase II Radiological Investigation	This investigation delineated the subsurface distribution of radium-containing devices in the disposal area at IR-02 Northwest and IR-02 Central. A removal action was recommended to address radiological contamination in this area. The removal action at IR-02 Northwest and IR-02 Central was performed from 2005 to 2007.
1994	SI	Site assessments were completed at Parcels B, C, D, and E and included field investigations at 75 sites. Further investigation was recommended for 28 of the 75 sites assessed. The PA/SI determined that the majority of the potential source areas required additional investigation (PRC, LFR, and Uribe and Associates, 1996a).

Table 10. Pre-ROD Response Actions for Parcel E (i.e., Parcels E, E-2, and UC-3) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
10/1997	RI	Based on the results from more than 4,700 soil and 1,200 groundwater samples, the RI Report recommended that all Parcel E sites be carried forward to an FS. Additionally, the report noted that additional soil and groundwater samples should be collected to better define the nature and extent of contamination at the parcel. The Parcel E RI also included a baseline ERA and HHRA.
1996	Exploratory Excavations at IR-11/14/15	About 36 cubic yards of arsenic- and mercury-contaminated soil was excavated from an area east of Building 521 at IR-11/14/15 (IT Corporation, 1999a).
1996–1997	Removal of Sediment from the Storm Drain System	More than 1,200 tons of sediment and debris was removed from storm drain lines across HPNS, including from storm drain lines in Parcel E.
1996–1997	Phase III Radiological Investigation	The investigation included surveys and swipe sampling at former NRDL buildings at Parcel E. Based on the investigation results, the report recommended (1) further investigation and potential excavation at former Buildings 509 and 517, where anomalous gamma activity was measured; (2) excavation of a potential buried point source behind Building 529; and (3) further investigation of Building 707 and its concrete pad.
1996–1998	Installation of Sheet-Pile Wall and Low-Permeability Cap at the Former Oily Waste Ponds in IR-03	A 900-foot-long sheet-pile wall was installed to a maximum depth of 27 feet bgs to reduce the potential for oil to migrate from IR-03 to San Francisco Bay. A geosynthetic clay liner with a 1-foot topsoil layer was placed over the area to minimize rainfall infiltration (IT Corporation, 1999b).
1997–1998	FS	Based on the data presented in the RI Report, the FS Report identified and evaluated remedial alternatives for Parcel E. However, the FS Report was not finalized because the Navy and regulatory agencies identified additional tasks to better characterize the nature and extent of contamination at Parcel E. These tasks were performed as part of data gaps investigations from 2000 through 2003, and results of these investigations were used in the Revised RI and FS Reports for Parcel E.
1997–1998	Groundwater Extraction System and Containment Barrier	A sheet-pile wall and groundwater extraction system were constructed along the southeastern portion of Parcel E-2 to prevent the potential transport of PCBs in groundwater to the bay (IT Corporation, 1999c).
1998–1999	Phase IV Radiological Investigation	In total, 38 concrete and 38 soil samples were collected from the Building 707 concrete pad area and analyzed for radionuclides. Based on the investigation results, a removal action was recommended to address elevated radioactivity at the concrete pad. The removal action at Building 707 was performed as part of the basewide radiological removal action that was initiated in 2009.

Table 10. Pre-ROD Response Actions for Parcel E (i.e., Parcels E, E-2, and UC-3) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
1999–2000	Parcel E Validation Study and Protective Soil Concentrations Technical Memorandum	Results of the study concluded cadmium, copper, lead, nickel, selenium, and zinc posed a potential unacceptable risk to wildlife at Parcel E. Protective soil concentrations were subsequently derived for these chemicals and used to evaluate risk to wildlife in the Revised Parcel E RI Report.
2000–2001	Interim Landfill Cap Construction	An interim cap was constructed over the landfill. The cap consisted of a multilayer system of sub-base soil, high-density polyethylene membrane, synthetic drainage layer, and topsoil and covered about 14.5 acres. The cap smothered any remaining subsurface smoldering areas following a brush fire on August 16, 2000, and also significantly reduced stormwater infiltration (TtEMI, 2005).
2000–2002	Groundwater Data Gaps Investigation	Water level measurements and results of a tidal study were used to refine the Parcel E hydrogeological conceptual model, and three rounds of groundwater monitoring data were used to develop a basewide groundwater monitoring program and to refine the nature and extent evaluation presented in the Revised RI Report.
2001–2002	Nonstandard Data Gaps Investigation	Separate evaluations were conducted to (1) delineate and characterize LFG, (2) identify the lateral extent of soil waste, and (3) assess the potential for subsurface layers to liquefy during an earthquake (TtEMI, 2003g and 2004g; TtEMI and ITSI, 2004b).
2000–2002	SVE Treatability Study	An SVE treatability study was completed at Building 406. The SVE system, which consisted of 3 SVE wells and 15 vapor monitoring wells, removed about 7 pounds of VOCs, with over 90 percent of the VOC mass attributed to TCE (IT Corporation, 2002f).
2001	Removal of Soil with Non-VOCs at IR-08	About 1,550 cubic yards of soil contaminated by PCBs and PAHs was excavated from four remediation areas at IR-08 (TtEMI and IT Corporation, 2001).
2001	Radiological Investigation of Parcel E Shoreline	Several areas contained gamma activity at levels exceeding background, most notably in the Metal Reef Area in IR-02 Southeast. A removal action was recommended to address radioactive materials in this area. The removal action at the Metal Reef Area was performed from 2005 to 2007.
2001–2002	Wetland Delineation and Wetland Functions Assessment	About 0.73 acres of tidal wetland areas was identified along the Parcel E shoreline. The functions and values assessment found that the value of these wetlands was low, and the most significant function of the wetlands was seasonal wildlife use for wintering and migrating birds.
2001–2005	Radiological Investigations, Phase V (and other interim investigations)	In 2001, a characterization survey of the Parcels E and E-2 shoreline was performed that identified the Metal Slag Area. The Phase V investigation was performed from 2002 to 2003. At Parcel E, 21 buildings or former building locations were evaluated as part of Phase V. Future investigation and cleanup were recommended for several sites, including Building 406; the area around former Buildings 506, 520, and 529; the Building 707 concrete pad and drains; the Shack 80 site; and IR-04.

Table 10. Pre-ROD Response Actions for Parcel E (i.e., Parcels E, E-2, and UC-3) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
2002	Standard Data Gaps Investigation	Data from this investigation were used in the Revised Parcel E RI Report to identify potential source areas of contamination, evaluate the nature and extent of soil contamination in each reuse area, and evaluate risk to human health and the environment.
2002–2004	Waste Consolidation and Removal	Industrial process equipment was decontaminated, and waste was removed and consolidated throughout Parcel E, including waste material stored in or near buildings and removal or encapsulation of ACM. Eight ASTs located at Building 521 were also removed (Tetra Tech FW, Inc., 2004b).
2002–2003	Construction of LFG Control System	A landfill gas control system was constructed along the northern edge of Parcel E-2 to reduce concentrations of methane in the subsurface and to prevent migration of landfill gas onto the nearby UCSF property (TtEMI, 2004a).
2002–2005	Parcels E and E-2 Shoreline Investigation and Risk Assessment	Shoreline investigation and associated ERA identified a potential risk to benthic invertebrates, birds, and mammals from exposure to metals and total PCBs in surface and subsurface sediments along the shoreline. Based on these results, source control measures were recommended for the Parcel E shoreline, particularly in IR-02 Northwest.
2003–2004	HRA	The HRA identified 33 areas in Parcel E as radiologically impacted. These sites included small areas such as former building foundation footprints and fill areas that may contain dials, gauges, deck markers, or sandblast waste. The HRA also identified basewide utility systems as impacted sites, including the underground storm drain and sanitary sewer lines. The HRA reported that no radiological contamination was suspected in groundwater at Parcel E, except at IR-02 and areas where storm drains are present; these areas have a low potential for groundwater contamination. The HRA concluded that further evaluation of the impacted sites was required (NAVSEA, 2004).
2003–2004	Parcel E Shoreline Debris Removal	Bricks and other industrial debris along the Parcel E shoreline were collected for disposal. About 468 cubic yards of non-RCRA hazardous waste debris (poles with creosote), about 400 cubic yards of nonregulated nonhazardous debris, and about 81 tons of recyclable metals were removed (Tetra Tech FW, Inc., 2004).
2003	Stockpile Inventory	The Navy inventoried all stockpiles at HPNS and identified 80 stockpiles at Parcel E.
2003–2004	Removal of Soil Stockpiles	Five soil stockpiles were removed from IR-73 and IR-02 Southeast and disposed of off site (TtEMI and ITSI, 2005).
2003–Present	Landfill Gas Monitoring and Control	Landfill gas is being monitored on a regular basis under the Interim Landfill Gas Monitoring and Control Plan to verify that hazardous concentrations of landfill gas are not migrating beyond the fence line of the landfill and onto the UCSF compound. The landfill gas control system is operated using both passive venting and active extraction.

Table 10. Pre-ROD Response Actions for Parcel E (i.e., Parcels E, E-2, and UC-3) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
2004	Removal of TPH-Contaminated Soil from Various Locations	Six areas at IR-05, IR-36 West, IR-39, and IR-73 were excavated to remove soil containing TPH at concentrations exceeding the screening criterion of 3,500 mg/kg. More than 13,000 cubic yards of soil was removed from these areas and disposed of off site.
2004	Metal Slag Area Characterization	Investigation included characterizing debris and slag in the Metal Slag Area suspected to have originated from the metal foundry (Building 241 in Parcel C) and the smelter (Building 408 in Parcel D) when the shipyard was active (Tetra Tech FW, Inc., 2005).
2005–2007	Metal Debris Reef and Metal Slag Area Removal Action	Approximately 11,200 cubic yards of soil, metal slag, and debris was removed from the Metal Debris Reef area of IR-02 Southeast and the metal slag area of Parcel E-2 and disposed of off site. LLRW, including131 devices and button sources and 31 cubic yards of metal debris, was also removed (TtEC, 2007b).
2005–2007	Removal of Soil at IR-02 Northwest and IR-02 Central Area	Approximately 49,500 cubic yards of soil was removed from the IR-02 Northwest and Central areas and disposed of off site. LLRW, including 11,840 tons of soil, 2,342 devices and button sources, 420 tons of firebrick, 1,940 tons of metal debris, and 58 tons of miscellaneous debris (concrete, plastic, hoses, and rocks), was also removed (TtEC, 2007c).
2005–2007	PCB Hot Spot Area Removal Action (Phase I)	Approximately 44,500 cubic yards of soil and debris was removed from the PCB Hot Spot Area in the southern portion of Parcel E-2 and disposed of off site. LLRW, including 533 cy of soil and fire brick, 40 devices, and 78 cubic yards of metal debris, was also removed (TtEC, 2007a).
2008	Revised RI, including HHRA and ERA	During the Revised RI, additional data were collected to better characterize Parcel E to support remedy evaluation at the site. To address data gaps, additional field investigations were performed to gather supplementary information needed to support the remedy evaluation.
2009–2011	Groundwater Treatability Study at IR-56	Treatability study evaluated the use of ZVI to treat groundwater at IR-56.
2009–2012	Groundwater Characterization and ZVI Treatability Study at Various VOC Groundwater Plumes	The study further characterized VOC groundwater plumes in Parcel E and evaluated the effectiveness of ZVI injection in reducing VOC concentrations at two plumes (IR-12 PCE plume and Building 406 TCE plume). The characterization refined the extent of the VOC groundwater plumes and identified elevated VOC concentrations in soil gas at IR-04 and IR-36 (Building 406). The study determined that ZVI could effectively treat the VOC plumes but recommended additional monitoring to better assess post-injection groundwater conditions.

Table 10. Pre-ROD Response Actions for Parcel E (i.e., Parcels E, E-2, and UC-3) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
2009–present	Basewide Radiological TCRA	TCRA activities identified and removed LLRW with radioactivity levels exceeding the TCRA removal goals and remediation goals at all radiologically affected sites, including storm drain and sewer lines. The fieldwork on Parcel UC-3 was completed in June 2011.
2010–2012	PCB Hot Spot Area Removal Action (Phase II)	Approximately 42,200 cubic yards of additional soil and debris from the PCB Hot Spot Area, mainly bayward of the 2005 to 2007 removal actions, was removed and disposed of off site. LLRW, including 5,800 cubic yards of soil, concrete, fire brick, and metal wire and 56 devices, was also removed (Shaw, 2013e).
2011–2016	Characterization and Treatability Study at IR-03	An initial study (from 2011 to 2012) further characterized the extent of NAPL at IR-03, and tested heating technologies (to enhance NAPL removal) on a bench-scale. A pilot-scale study was completed in 2014 to test two technologies (in-situ stabilization/solidification and thermally enhanced NAPL extraction) in the field. An additional study was completed in 2015 to further characterize the NAPL extents and support a remedial design for IR-03 (ITSI, 2013; Cabrera Insight JV and CDM Smith, 2016a and 2016b).
2012	Ship-Shielding Area Removal Action	The top 1 foot of soil was removed from the 1.1-acre ship shielding range. In total, 3,413 cubic yards of excavated soil was screen to verify cobalt-60 was not detected above the release criterion.
8/2012	Final FS	The FS identified, screened, and evaluated remedial alternatives for cleanup of soil and groundwater at Parcel E.
11/2012	ROD for Parcel E-2	The selected remedy documented in the original ROD included excavation and offsite disposal of contaminated soil and sediment, radiological remediation of soil, sediment, and structures, soil cover with protective liner, shoreline revetment, below-ground barriers, removal and treatment of landfill gas, and monitoring, maintenance, and institutional controls.
2013	Soil Excavation Characterization	A soil investigation was conducted to determine the lateral and vertical extent of COCs associated with excavation areas in Parcel UC-3.
12/2013	ROD for Parcel E	The selected remedy documented in the original ROD included excavation and offsite disposal of contaminated soil and sediment, radiological remediation of soil and structures, SVE, durable covers and shoreline protection, groundwater treatment using ZVI and ISB, MNA, below-ground barriers and protective liners, groundwater monitoring, containment and in-situ stabilization of NAPL at IR-03, and institutional controls.
1/2014	ROD for Parcel UC-3	The selected remedy documented in the original ROD included excavation and offsite disposal of contaminated soil, radiological remediation of soil and structures, clean and close steam lines, soil gas monitoring, durable covers, groundwater treatment using ISB, MNA, and institutional controls.

Table 10. Pre-ROD Response Actions for Parcel E (i.e., Parcels E, E-2, and UC-3) *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Notes:

1 = The documents listed are available in the Administrative Record and provide detailed information used to support remedy selection at Parcels E, E-2, and UC-3.

ACM = asbestos-containing material
ASTs = aboveground storage tanks
Battelle = Battelle Memorial Institute
bgs = below ground surface
Cabrera = Cabrera Services, Inc.
COPECs = chemicals of potential ecological concern
ERA = ecological risk assessment
ERM-West = Environmental Resources Management West, Inc.
FS = Feasibility Study
HHRA = human health risk assessment
HLA = Harding Lawson Associates
HPNS = Hunters Point Naval Shipyard
HRA = Historical Radiological Assessment
Insight = Insight Environmental, Engineering, and Construction, Inc.
IR = Installation Restoration
ITSI = Innovative Technical Solutions, Inc.
ISB = in-situ bioremediation
JV = Joint Venture
LFR = Levine Fricke Recon
LLRW = low-level radioactive waste
mg/kg = milligrams per kilogram
MNA = monitored natural attenuation
NAPL = nonaqueous-phase liquid
NAVSEA = Naval Sea Systems Command
NRDL = Naval Radiological Defense Laboratory
OU = Operable Unit
PAHs = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
PCE = tetrachloroethene
PRC = PRC Environmental Management, Inc.
RCRA = Resource Conservation and Recovery Act
RI = Remedial Investigation
Shaw = Shaw Environmental, Inc.
SVE = soil vapor extraction
TCE = trichloroethene
TCRA = time-critical removal action
TPH = total petroleum hydrocarbons
TtEMI = Tetra Tech EM Inc.
UCSF = University of California, San Francisco
USTs = underground storage tanks
VOCs = volatile organic compounds
ZVI = zero-valent iron

Table 11. RAOs and Remedy Components for Parcel E
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Soil, Soil Gas, and Shoreline Sediment		
Prevent exposure of humans to COCs in soil at concentrations exceeding remediation goals for (1) ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 10 feet bgs by residents in areas zoned for mixed-use reuse; (2) ingestion of homegrown produce in native soil in areas zoned for mixed-use reuse; (3) ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 2 feet bgs by recreational users in areas zoned for open space reuse; and (4) ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 10 feet bgs by construction workers in all areas.	▪ Excavation and offsite disposal of Tier 1, Tier 2, and TPH locations ▪ Closure of fuel and steam lines	▪ Durable covers ▪ Monitoring, maintenance, and ICs
Prevent exposure of humans to VOCs in soil gas at concentrations that would pose unacceptable risk via indoor inhalation of vapors.	▪ Excavation and offsite disposal of Tier 1 and Tier 2 locations ▪ SVE at Building 406 ▪ In-situ groundwater treatment at Building 406, IR-04, and IR-12	▪ Soil gas surveys ▪ Monitoring and ICs
Prevent exposure of humans to COCs in shoreline sediment at concentrations exceeding remediation goals.	▪ Excavation and offsite disposal of Tier 1, Tier 2, and TPH locations ▪ Shoreline protection (excavate sediment)	▪ Shoreline protection (place protective material) ▪ Monitoring, maintenance, and ICs
Prevent exposure of benthic invertebrates, birds, and mammals to COECs in shoreline sediment at concentrations exceeding remediation goals.	▪ Excavation and offsite disposal of Tier 1, Tier 2, and TPH locations ▪ Shoreline protection (excavate sediment)	▪ Shoreline protection (place protective material) ▪ Monitoring, maintenance, and ICs

Table 11. RAOs and Remedy Components for Parcel E *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Groundwater		
Prevent or minimize exposure of construction workers to VOCs in A-aquifer groundwater by dermal exposure and inhalation of vapors with chemicals exceeding remediation goals.	▪ In-situ groundwater treatment at Building 406, IR-04, and IR-12	▪ Soil gas surveys ▪ Monitoring and ICs
Prevent or minimize exposure of humans to COCs in the B-aquifer at concentrations exceeding remediation goals via the domestic use pathway.	▪ No treatment required	▪ Monitoring (MNA) and ICs
Prevent or minimize migration of arsenic, copper, lead, nickel, zinc, Aroclor-1254, Aroclor-1260, alpha-chlordane, and 4,4'-DDE to prevent discharge (into San Francisco Bay) that would result in concentrations exceeding corresponding surface water quality criteria for aquatic wildlife.	▪ Excavation and offsite disposal of Tier 1 and Tier 2 locations ▪ NAPL source removal and treatment at IR-03	▪ Durable cover (with protective liner) ▪ Groundwater controls (below-ground barrier) at IR-02 Northwest and IR-03 ▪ Monitoring (MNA), maintenance, and ICs
Prevent or minimize migration of A-aquifer groundwater containing total TPH concentrations greater than 1,400 µg/L (where commingled with CERCLA-regulated substances) into San Francisco Bay.	▪ Excavation and offsite disposal of TPH locations ▪ NAPL source removal and treatment at IR-03 ▪ Groundwater treatment at IR-03	▪ Durable cover (with protective liner) ▪ Groundwater controls (below-ground barrier) at IR-02 Northwest and IR-03 ▪ Monitoring (MNA), maintenance, and ICs
NAPL at IR-03 (Former Oily Waste Ponds)		
Prevent or minimize migration of NAPL to prevent discharge that would result in concentrations of COECs exceeding corresponding surface water quality criteria for aquatic wildlife.	▪ NAPL source removal and treatment at IR-03 ▪ Groundwater treatment at IR-03	▪ Durable cover (with protective liner) ▪ Groundwater controls (below-ground barrier) at IR-03 ▪ Monitoring (MNA), maintenance, and ICs

Table 11. RAOs and Remedy Components for Parcel E *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
NAPL at IR-03 (Former Oily Waste Ponds) *(continued)*		
Prevent or minimize migration of NAPL to prevent discharge that would result in total TPH groundwater concentrations greater than 1,400 µg/L into San Francisco Bay.	▪ NAPL source removal and treatment at IR-03 ▪ Groundwater treatment at IR-03	▪ Groundwater controls (below-ground barrier) at IR-03 ▪ Monitoring (MNA), maintenance, and ICs
Radiologically Impacted Media (Soil, Shoreline Sediment, and Structures)		
Prevent exposure to ROCs at activity levels that exceed remediation goals for all potentially complete exposure pathways (which include external exposure, ingestion, and inhalation of soil based on the conceptual site model for human health).	▪ Radiological surveys and remediation ▪ Radiological surface surveys and removal of anomalies	▪ Durable covers (with demarcation layer at IR-02 and IR-03) ▪ Monitoring, maintenance, and ICs

Notes:
bgs = below ground surface
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
COCs = chemicals of concern
COECs = chemicals of ecological concern
DDE = dichlorodiphenyldichloroethene
ICs = institutional controls
IR = Installation Restoration
MNA = monitored natural attenuation
NAPL = nonaqueous-phase liquids
RAOs = remedial action objectives
ROCs = radionuclides of concern
SVE = soil vapor extraction
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds
µg/L = micrograms per liter

Table 12. RAOs and Remedy Components for Parcel E-2
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Soil and Sediment		
Prevent human exposure to inorganic and organic chemicals at concentrations greater than remediation goals for the following exposure pathways: ▪ Ingestion of, outdoor inhalation of, and dermal exposure to solid waste, soil, or sediment from 0 to 2 feet bgs by recreational users throughout Parcel E-2. ▪ Ingestion of, outdoor air inhalation of, and dermal exposure to solid waste, soil, or sediment from 0 to 10 feet bgs by construction workers throughout Parcel E-2.	▪ Excavation and offsite disposal of soil, sediment, and debris at hot spot areas	▪ Soil cover (with protective liner) ▪ Shoreline revetment ▪ Onsite consolidation of waste materials beneath the soil cover ▪ Monitoring, maintenance, and ICs
Prevent terrestrial wildlife exposure to concentrations of inorganic and organic chemicals in solid waste or soil greater than remediation goals from 0 to 3 feet bgs throughout Parcel E-2.	▪ Excavation and offsite disposal of soil, sediment, and debris at hot spot areas	▪ Soil cover (with protective liner) ▪ Onsite consolidation of waste materials beneath the soil cover ▪ Monitoring, maintenance, and ICs
Prevent aquatic wildlife exposure to concentrations of inorganic and organic chemicals in intertidal sediment greater than remediation goals from 0 to 2.5 feet bgs throughout the Shoreline Area.	▪ Excavation and offsite disposal of soil, sediment, and debris at hot spot areas	▪ Shoreline revetment ▪ Monitoring, maintenance, and ICs
Prevent exposure to ROCs at activity levels that exceed remediation goals for all potentially complete exposure pathways.	▪ Radiological surveys and remediation (including radiological screening of excavated material) ▪ Radiological surface survey and removal of anomalies	▪ Soil cover (with demarcation layer) ▪ Monitoring, maintenance, and ICs

Table 12. RAOs and Remedy Components for Parcel E-2 *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Landfill Gas		
Control methane concentrations to 5 percent (by volume in air) or less at subsurface points of compliance.	▪ LFG controls (active LFG collection and treatment)	▪ Monitoring, maintenance, and ICs
Control methane concentrations to 1.25 percent (by volume in air) or less in onsite structures ("on site" defined in the Parcel E-2 ROD as any area within the subsurface points of compliance for landfill gas).	▪ LFG controls (active LFG collection and treatment)	▪ Monitoring, maintenance, and ICs
Prevent exposure to NMOCs at concentrations greater than 500 ppmv at the subsurface points of compliance.	▪ LFG controls (active LFG collection and treatment)	▪ Monitoring, maintenance, and ICs
Prevent exposure to NMOCs at concentrations greater than 5 ppmv above background levels in the breathing zone of onsite workers and visitors.	▪ LFG controls (active LFG collection and treatment)	▪ Monitoring, maintenance, and ICs
Groundwater (Domestic Use)		
Prevent exposure to groundwater that may contain COCs at concentrations greater than remediation goals through the domestic use pathway.	▪ No treatment required	▪ Monitoring (MNA) and ICs
Prevent or minimize migration of B-aquifer groundwater that may contain COCs at concentrations greater than remediation goals beyond the point of compliance (defined in the RI/FS Report at the downgradient boundary of Parcel E-2).	▪ No treatment required	▪ Monitoring (MNA) and ICs
Groundwater (Construction Worker)		
Prevent or minimize dermal exposure to and vapor inhalation from A-aquifer groundwater containing COCs at concentrations greater than remediation goals by construction workers.	▪ No treatment required	▪ Monitoring (MNA) and ICs

Table 12. RAOs and Remedy Components for Parcel E-2 *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Groundwater (Protection of Wildlife)		
Prevent or minimize migration of COPECs to prevent discharge that would result in concentrations greater than the corresponding water quality criteria for aquatic wildlife.	▪ No treatment required	▪ Groundwater controls (consisting of below-ground barriers) to limit contaminant migration ▪ Soil cover (with protective liner that limits surface water infiltration) ▪ Monitoring (MNA), maintenance, and ICs
Prevent or minimize migration of A-aquifer groundwater containing total TPH concentrations greater than the remediation goal (where commingled with CERCLA substances) into San Francisco Bay.	▪ No treatment required	▪ Groundwater controls (consisting of below-ground barriers) to limit contaminant migration ▪ Soil cover (with protective liner that limits surface water infiltration) ▪ Monitoring (MNA), maintenance, and ICs
Surface Water		
Prevent or minimize migration of COPECs to prevent discharge that would result in concentrations greater than the corresponding water quality criteria for aquatic wildlife.	▪ No treatment required	▪ Groundwater controls (consisting of below-ground barriers) to limit contaminant migration ▪ Soil cover (with protective liner to limit surface water infiltration) ▪ Monitoring (MNA), maintenance, and ICs

Notes:
bgs = below ground surface
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
COCs = chemicals of concern
COPECs = chemicals of potential ecological concern
ICs = institutional controls
MNA = monitored natural attenuation
NMOCs = nonmethane organic compounds
ppmv = parts per million by volume
RAOs = remedial action objectives
RI/FS = Remedial Investigation/Feasibility Study
ROCs = radionuclides of concern
ROD = Record of Decision
TPH = total petroleum hydrocarbons

Table 13. RAOs and Remedy Components for Parcel UC-3
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Soil and Soil Gas		
Prevent unacceptable exposure of humans to chemicals and radionuclides in soil at concentrations exceeding the remediation goals (see Table 7 of the ROD [Navy, 2014a]) for the following exposure pathways: ▪ Ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 10 feet bgs by residents in areas zoned for mixed-use reuse. ▪ Ingestion of homegrown produce in native soil in areas zoned for mixed-use reuse. ▪ Ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 10 feet bgs by construction workers in all areas. ▪ Ingestion of, outdoor inhalation of, and dermal exposure to soil from 0 to 10 feet bgs by industrial users of the railroad right-of-way.	▪ Excavation and offsite disposal of soil from Tier 2 and TPH locations ▪ Steam line closure[1]	▪ Durable covers within Redevelopment Block MU-3 ▪ Monitoring, maintenance, and ICs
Prevent exposure of humans to VOCs in soil gas at concentrations that would pose unacceptable risk via indoor inhalation of vapors. Table 7 of the final soil gas memorandum (ChaduxTt, 2011g) lists risk-based action levels for various volatile chemicals, including SVOCs that may pose an unacceptable risk via indoor inhalation of vapors. *Note: The soil gas action levels referenced in the RAO will be used for an initial risk-based screening of data collected during future soil gas surveys (such as the surveys to be performed at the IR-56 VOC groundwater plume following active treatment). After the initial risk-based screening, areas with unacceptable risk will be further evaluated using location-specific data (i.e., physical characteristics of the soil) to assess potential exposures consistent with the State of California and EPA vapor intrusion guidance. In addition, risks and hazards at these areas will be further characterized using the accepted methodology for risk assessments at HPNS.*	▪ None	▪ Soil gas surveys ▪ Monitoring and ICs

Table 13. RAOs and Remedy Components for Parcel UC-3 *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

RAO	Remedy Component: Removal or Treatment of Contaminant Mass	Remedy Component: Containment, Monitoring, Maintenance, and ICs
Groundwater		
Prevent or minimize unacceptable exposure of humans to COCs in the B-aquifer at concentrations exceeding remediation goals (see Table 8 of the ROD [Navy, 2014a]) via the domestic use pathway.	▪ Anaerobic in-situ bioremediation at IR-56[2]	▪ MNA and ICs
Prevent or minimize unacceptable exposure of construction workers to VOCs in A-aquifer groundwater by dermal exposure and inhalation of vapors with chemicals exceeding remediation goals.	▪ Anaerobic in-situ bioremediation at IR-56[2]	▪ MNA and ICs
Radiologically Impacted Soil and Structures		
Prevent exposure to radiological isotopes at activity levels that exceed remediation goals for all potentially complete exposure pathways (which include external exposure, ingestion, and inhalation of soil based on the conceptual site model for human health. *Note: The RAO for radiologically impacted media was satisfied prior to publication of the ROD through removal actions at Parcel UC-3. Excavation of radiologically impacted sewer and storm drain lines was completed under a TCRA in 2011. The removal action included all sewer and storm drain lines as well as potentially impacted soil. A Radiological RACR for Parcel UC-3 was submitted on March 16, 2012. Accordingly no additional actions were performed during the remedial action. However, all previous radiological work is currently being reviewed to determine if current site conditions are compliant with the RAOs (see Section 6.1.6 for further information).*	▪ Radiological surveys and remediation	▪ None

Table 13. RAOs and Remedy Components for Parcel UC-3 *(continued)*
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Notes:

1 = The steam line closure component of the selected soil remedy was deemed unnecessary to achieve the soil RAO, because the steam lines within Parcel UC-3 were (1) not used for conveying oil; (2) assessed during previous site investigations and found to display no evidence of contamination; and (3) found to be outside the area where previous investigations had identified waste oil contamination in steam lines (Amec Foster Wheeler Environment & Infrastructure, Inc., 2016a).

2 = Groundwater monitoring conducted in Parcel UC-3 revealed that TCE concentrations at the IR-56 plume have been less than the remediation goal in the Final ROD since monitoring began in 1996, and below the vapor intrusion criterion since the end of 2009 (Amec Foster Wheeler Environment & Infrastructure, Inc., 2016a). As a result, remediation of groundwater by in-situ bioremediation, as specified in the Final ROD (Navy, 2014a), was deemed unnecessary to achieve the groundwater RAOs and was excluded from the remedial design.

bgs = below ground surface

COCs = chemicals of concern

DTSC = Department of Toxic Substances Control

EPA = U.S. Environmental Protection Agency

ICs = institutional controls

IR = Installation Restoration

MNA = monitored natural attenuation

Navy = Department of the Navy

RACR = Remedial Action Completion Report

RAOs = remedial action objectives

ROD = Record of Decision

SVOCs = semivolatile organic compounds

TCE = trichloroethene

TCRA = time-critical removal action

TPH = total petroleum hydrocarbons

VOCs = volatile organic compounds

Table 14. Pre-ROD Response Actions for Parcel F
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Date(s)	Response Action[1]	Description
1998	Draft FS	Data from the FS established two remediation footprints for Parcel F based on different decision flow processes. Five areas (I, III, VIII, IX, and X) were identified as the areas of highest ecological hazard (TtEMI and LFR, 1998a).
2000	Validation Study	A Validation Study was conducted to further investigate five areas identified in the FS and to refine the ERA.
2002	Shoreline Characterization to Evaluate Sediment Contamination	Shoreline characterization to evaluate whether contamination in Parcels E and E-2 had the potential to migrate, or had already migrated, to sediments in the adjacent offshore area of Parcel F (SulTech, 2005).
2003	FS Data Gaps Investigation	The data gaps investigation was conducted to collect additional data for subtidal sediment to support the Parcel F FS Report for Areas III and X, and to delineate surface sediments for mercury between Areas VIII and IX (Battelle, Neptune & Company, and Sea Engineering, Inc., 2007).
2006–2007	Sediment Treatability Study	Treatability study for sediment in tidal mudflats using activated carbon for field treatment of PCBs (Cho et al., 2007).
4/2008	Final FS	The FS identified, screened, and evaluated remedial alternatives for cleanup of sediment at Parcel F (Barajas & Associates, Inc., 2008a).
1/2011–9/2011	Removal of Wooden Remnants	Wooden piers and remnants of wooden berths, quay walls, and wharves adjacent to Parcels B and C were removed and disposed of off site (ERS Joint Venture, 2012).
2009–2013	Radiological Data Gaps Investigations	Radiological data gaps investigations (Battelle and Sea Engineering, Inc., 2013 and ITSI Gilbane and SAIC, 2013).
1/2016	FS Addendum	The FS addendum specified that no additional radiological investigation or remediation for radionuclides in sediment is warranted and institutional controls will be implemented to manage the risk associated with future exposure to radiological objects during dredging.
2016–2017	Activated Carbon Field Demonstration	A field study was performed to demonstrate the effectiveness of activated carbon as a means of sequestering PCBs in sediment at Parcel F. The results of the study confirmed the technology's viability as a treatment method for Parcel F.
4/2018	Proposed Plan	The Proposed Plan recommends focused removal/backfill, offsite disposal, capping, and institutional controls for Area III, and focused removal/backfill, in-situ treatment, offsite disposal, monitored natural recovery, and institutional controls for Areas IX and X. The ROD for Parcel F has not been published.

Notes:
Battelle = Battelle Memorial Institute
ERA = ecological risk assessment
FS = Feasibility Study
LFR = Levine Fricke Recon
PCBs = polychlorinated biphenyls
TtEMI = Tetra Tech EM Inc.

Table 15. IC Summary Table

Media, Engineered Controls, and Areas that Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective[1]	Title of IC Instrument Implemented and Date (or planned)
IR-07/18					
Soil, Sediment, Soil Gas, and Groundwater	Yes	Yes	IR-07/18 (entire site)	▪ Parcel-wide restriction (without FFA signatory approval) on land-disturbing activities; growing any edible items; alteration, disturbance, or removal of any remedy component; extraction of groundwater and installation of new groundwater monitoring wells (excluding environmental sampling/monitoring requirements); and removal of or damage to security features ▪ Restriction (without FFA signatory approval) on construction of enclosed structures within VOC ARIC[3] ▪ Implement Risk Management Plan (if necessary) that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories	Restrictive covenants[2] in Quitclaim Deed(s) (planned/TBD) and Covenant(s) to Restrict Use of Property[2] (planned/TBD)
Radiologically Impacted Soil and Sediment			IR-07/18 (within radiological ARIC)	▪ Restricted to open space and recreational use; prohibited land uses include for residences, hospitals, schools, and daycare facilities. ▪ Parcel-wide restrictions (described above) are also subject to both FFA signatory and CDPH approval ▪ Additional restrictions (subject to FFA signatory and CDPH approval) include excavation below demarcation layer and installation of water lines, storm drains, or sanitary sewers above demarcation layer ▪ Implement Risk Management Plan that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories and CDPH	
Parcels B-1 and B-2					
Soil, Sediment, Soil Gas, and Groundwater	Yes	Yes	B-1 and B-2 (entire parcels)	▪ Parcel-wide restriction (without FFA approval) on land-disturbing activities; growing any edible items; alteration, disturbance, or removal of any remedy component; extraction of groundwater and installation of new groundwater monitoring wells (except for construction, operation, or maintenance responses); and removal of or damage to security features ▪ Restriction (without FFA signatory approval) on construction of enclosed structures within VOC ARIC[3] ▪ Implement Risk Management Plan (if necessary) that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories.	Restrictive covenants[2] in Quitclaim Deed(s) (planned/TBD) and Covenant(s) to Restrict Use of Property[2] (planned/TBD)

Table 15. IC Summary Table *(continued)*

Media, Engineered Controls, and Areas that Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective[1]	Title of IC Instrument Implemented and Date (or planned)
Parcel C					
Soil, Soil Gas, and Groundwater	Yes	Yes	C (entire parcel)	▪ Restrict land uses in areas designated for open space, educational/cultural, and maritime/industrial land uses (without FFA signatory approval); prohibited land uses within these areas include residences, hospitals, schools, and daycare facilities. ▪ Parcel-wide restriction (without FFA approval) on land-disturbing activities; growing any edible items; alteration, disturbance, or removal of any remedy component; extraction of groundwater and installation of new groundwater monitoring wells (except for construction, operation, or maintenance responses); and removal of or damage to security features ▪ Restriction (without FFA signatory approval) on construction of enclosed structures within VOC ARIC[3] ▪ Implement Risk Management Plan (if necessary) that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories.	Restrictive covenants[2] in Quitclaim Deed(s) (planned/TBD) and Covenant(s) to Restrict Use of Property[2] (planned/TBD)
Parcel D-1					
Soil, Soil Gas, and Groundwater	Yes	Yes	D-1 (entire parcel)[4]	▪ Restrict land uses in areas designated for industrial and maritime/industrial land uses (without FFA signatory approval); prohibited land uses within these areas include residences, hospitals, schools, and daycare facilities. ▪ Parcel-wide restriction (without FFA approval) land-disturbing activity; growing any edible items; alteration, disturbance, or removal of any remedy component; extraction of groundwater and installation of new groundwater monitoring wells (except for construction, operation, or maintenance responses); and removal of or damage to security features ▪ Restriction (without FFA signatory approval) on construction of enclosed structures within VOC ARIC[3] ▪ Implement Risk Management Plan (if necessary) that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories	Restrictive covenants[2] in Quitclaim Deed(s) (planned/TBD) and Covenant(s) to Restrict Use of Property[2] (planned/TBD)

Table 15. IC Summary Table *(continued)*

Media, Engineered Controls, and Areas that Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective[1]	Title of IC Instrument Implemented and Date (or planned)
Parcel E					
Soil, Soil Gas, Sediment, and Groundwater	Yes	Yes	E (entire parcel)	▪ Parcel-wide restriction (without FFA approval) on land-disturbing activities; growing any edible items; alteration, disturbance, or removal of any remedy component; extraction of groundwater and installation of new groundwater monitoring wells (except for construction, operation, or maintenance responses); and removal of or damage to security features ▪ Restriction (without FFA signatory approval) on construction of enclosed structures within VOC ARIC[3] ▪ Restrict land uses in areas designated for open space and recreational land uses (without FFA signatory approval); prohibited land uses within these areas include residences, hospitals, schools, and daycare facilities. ▪ Implement Risk Management Plan (if necessary) that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories	Restrictive covenants[2] in Quitclaim Deed(s) (planned/TBD) and Covenant(s) to Restrict Use of Property[2] (planned/TBD)
Radiologically Impacted Soil and Sediment	Yes	Yes	IR-02 and IR-03 (within radiological ARIC)	▪ Parcel-wide restrictions (described above) are also subject to both FFA signatory and CDPH approval ▪ Additional restrictions (subject to FFA signatory and CDPH approval) include excavation below demarcation layer and installation of water lines, storm drains, or sanitary sewers above demarcation layer ▪ Implement Risk Management Plan that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories and CDPH	
Parcel E-2					
Soil, Subsurface (Landfill) Gas, Sediment, and Groundwater	Yes	Yes	E-2 (entire parcel)	▪ Parcel-wide restriction (without FFA signatory approval) on land-disturbing activities; growing any edible items; alteration, disturbance, or removal of any remedy component; extraction of groundwater and installation of new groundwater monitoring wells (excluding environmental sampling/monitoring requirements); and removal of or damage to security features ▪ Restriction (without FFA signatory approval) on construction of enclosed structures within ARIC for subsurface gas[3] ▪ Restricted to open space and recreational use (unless approval granted by FFA signatories); prohibited land uses throughout parcel include residences, hospitals, schools, daycare facilities, and permanently occupied structures (including those used for commercial/industrial purposes). ▪ Implement Risk Management Plan (if necessary) that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories	Restrictive covenants[2] in Quitclaim Deed(s) (planned/TBD) and Covenant(s) to Restrict Use of Property[2] (planned/TBD) and Easements or appropriate legal mechanisms for portion of UCSF property (which contains part of the Parcel E-2 Landfill) to facilitate remedy implementation (planned/TBD)

Table 15. IC Summary Table *(continued)*

Media, Engineered Controls, and Areas that Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective[1]	Title of IC Instrument Implemented and Date (or planned)
Parcel E-2 *(continued)*					
Radiological Impacted Soil and Sediment	Yes	Yes	IR-01/21 and adjacent areas (within radiological ARIC)	▪ Parcel-wide restrictions (described on previous page) are also subject to both FFA signatory and CDPH approval ▪ Additional restrictions (subject to FFA signatory and CDPH approval) include excavation below demarcation layer and installation of water lines, storm drains, or sanitary sewers above demarcation layer ▪ Implement Risk Management Plan that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories and CDPH	Restrictive covenants[2] in Quitclaim Deed(s) (planned/TBD) and Covenant(s) to Restrict Use of Property[2] (planned/TBD) and Easements or appropriate legal mechanisms for portion of UCSF property (which contains part of the Parcel E-2 Landfill) to facilitate remedy implementation (planned/TBD)
Parcel G					
Soil, Soil Gas, and Groundwater	Yes	Yes	G (entire parcel)	▪ Land use is restricted for property areas designated for open space, educational/cultural, and industrial uses (unless approved by FFA signatories); prohibited land uses within these areas include residences, hospitals, schools, and daycare facilities. ▪ Parcel-wide restriction (without FFA approval) on land-disturbing activities; growing any edible items; alteration, disturbance, or removal of any remedy component; extraction of groundwater and installation of new groundwater monitoring wells (except for construction, operation, and maintenance); and removal of or damage to security features ▪ Restriction (without FFA signatory approval) on construction of enclosed structures within VOC ARIC[3] ▪ Implement Risk Management Plan (if necessary) that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories	Restrictive covenants[2] in Quitclaim Deed(s) (planned/TBD) and Covenant(s) to Restrict Use of Property[2] (planned/TBD)
Parcels UC-1 and UC-2					
Soil, Soil Gas, and Groundwater	Yes	Yes	UC-1 and UC-2 (entire parcels)	▪ Land use is restricted for property areas designated for open space, educational/cultural, and industrial uses (unless approved by FFA signatories); prohibited land uses include within these areas residences, hospitals, schools, and daycare facilities. ▪ Parcel-wide restriction (without FFA approval) on land-disturbing activities; growing any edible items; alteration, disturbance, or removal of any remedy component; extraction of groundwater and installation of new groundwater monitoring wells (except for construction, operation, and maintenance); and removal of or damage to security features ▪ Restriction (without FFA signatory approval) on construction of enclosed structures within VOC ARIC[3] ▪ Implement Risk Management Plan (if necessary) that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories	Restrictive covenants[2] in Quitclaim Deed(s) (September 2015) and Covenant(s) to Restrict Use of Property[2] (September 2015)

Table 15. IC Summary Table *(continued)*

Media, Engineered Controls, and Areas that Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective[1]	Title of IC Instrument Implemented and Date (or planned)
Parcel UC-3					
Soil, Soil Gas, and Groundwater	Yes	Yes	UC-3 (entire parcel)	▪ Parcel-wide restriction (without FFA approval) on (1) growing any edible items, and (2) extraction of groundwater and installation of new groundwater monitoring wells (except for construction, operation, and maintenance).	Restrictive covenants[2] in Quitclaim Deed(s) (planned/TBD) and Covenant(s) to Restrict Use of Property[2] (planned/TBD)
			Redevelopment Block MU-3 (eastern portion of Parcel UC-3, adjacent to Parcel E)	▪ Parcel-wide restriction (without FFA approval) on land-disturbing activities; alteration, disturbance, or removal of any remedy component; and removal of or damage to security features. ▪ Restriction (without FFA signatory approval) on construction of enclosed structures within VOC ARIC[3] ▪ Implement Risk Management Plan (if necessary) that sets forth requirement or protocols that allow certain activities that are otherwise restricted to be performed without additional approval by FFA signatories	
			Railroad Right-of-Way and Crisp Road (west of Redevelopment Block MU-3)	▪ Land use is restricted for property areas designated for industrial uses (unless approved by FFA signatories); prohibited land uses within these areas include residences, hospitals, schools, and daycare facilities.	

Notes:

1 Land use and activity restrictions are detailed in the Land Use Control Remedial Design (LUC RD) reports prepared for each parcel and approved by the FFA signatories. The summary information provided in this table is not intended to replace or revise the information presented in the approved LUC RD reports for each parcel.

2 The Covenant to Restrict Use of Property will incorporate the land use and activity restrictions into environmental restrictive covenants that run with the land and that are enforceable by DTSC and EPA against future transferees and users. The Quitclaim Deed will include the identical land use and activity restrictions in environmental restrictive covenants that run with the land and that will be enforceable by the Navy against future transferees.

3 Any proposed construction and occupancy of enclosed structures within the ARIC for VOC vapors (and ARIC for subsurface gas within Parcel E-2) must be approved by the FFA signatories in accordance with the CRUP, Quitclaim Deed, and LUC RD Report to ensure that the risks of potential exposures to VOC vapors (and, for Parcel E-2, other subsurface gas that may pose a risk to humans) are reduced to acceptable levels that are adequately protective of human health. The FFA signatories may modify the ARIC as soil contamination areas and groundwater contaminant plumes that are currently producing unacceptable vapor inhalation risks are reduced over time or in response to further soil, vapor, and groundwater sampling and analysis for VOCs that establishes that areas now included in the ARIC do not pose unacceptable vapor inhalation risks.

4 Additional restrictions related to radionuclides in portion of Parcel D-1 will be proposed in forthcoming amendment to LUC RD report.

ARIC = area requiring institutional controls

CDPH = California Department of Public Health

DTSC = California Department of Toxic Substances Control

EPA = U.S. Environmental Protection Agency

FFA = Federal Facility Agreement

ICs = institutional controls

IR = Installation Restoration

LUC RD = Land Use Control Remedial Design

TBD = to be determined

UU/UE = unlimited use/unrestricted exposure

VOCs = volatile organic compounds

Table 16. Soil Cleanup Levels
Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Primary COC in Soil	ROD Residential RG[1] (mg/kg)	ROD Industrial RG[1] (mg/kg)	Current Residential RSL[2] (mg/kg)	Current Industrial RSL[2] (mg/kg)	DTSC-SL Residential[3] (mg/kg)	DTSC-SL Industrial[3] (mg/kg)	Laboratory-Specific Limits Soil[4] (mg/kg)		
							DL	LOD	LOQ
Arsenic	11.1 (HPAL)	11.1 (HPAL)	0.68	3.0	0.11	0.36	NA	NA	NA
Benzo(a)pyrene	0.33 (PQL)	0.33 (PQL)	0.11	2.1	0.11	2.1	0.00047	0.0033	0.0066
Aroclor-1260	0.21 (RBC)	1.0 (RBC)	0.24	0.99	0.24	0.6	0.00801	0.01	0.033

Notes:

1 = As provided in the ROD for each parcel.

2 = EPA RSLs dated May 2018 (available online at: <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables>).

3 = CalEPA DTSC-SLs in "Human Health Risk Assessment (HHRA) Note; HERO HHRA Note Number: 3, DTSC-Modified Screening Levels (DTSC-SLs). Release Date: April 2019 (available online at: <http://www.dtsc.ca.gov/AssessingRisk/humanrisk2.cfm>).

4 = TestAmerica Laboratory-specific limits for soil using EPA Method 8270D SIM for PAHs and EPA Method 8082A for PCBs.

CalEPA = California Environmental Protection Agency
COC = chemical of concern
DL = detection limit
DTSC-SL = Department of Toxic Substances Control-modified screening level
EPA = U.S. Environmental Protection Agency
HPAL = Hunters Point ambient level
LOD = limit of detection
LOQ = limit of quantitation
mg/kg = milligrams per kilogram
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
PQL = practical quantitation limit
RBC = risk-based concentration
RG = remediation goal
ROD = Record of Decision

Table 17. Groundwater Cleanup Levels

Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California

Primary COC in Groundwater	ROD Residential RG for Vapor Intrusion[1] (µg/L)	ROD Industrial RG for Vapor Intrusion[1] (µg/L)	Residential VISL[2] (µg/L)	Industrial VISL[2] (µg/L)	Laboratory-Specific Limits for Groundwater[3] (µg/L)		
					DL	LOD	LOQ
Tetrachloroethene	1.0 (PQL)	1.0 (PQL)	15	65	0.18	0.05	1.0
Trichloroethene	2.9 (RBC)	4.8 (RBC)	1.2	7.4	0.25	0.5	1.0
Vinyl chloride	0.5 (PQL)	0.5 (PQL)	0.15	2.5	0.194	0.25	2.0

Notes:

1 = As provided in the ROD for each parcel.

2 = EPA VISLs available as an online calculator at: <https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-level-calculator>.

3 = TestAmerica Laboratory-specific limits for groundwater using EPA Method 8260B.

COC = chemical of concern

DL = detection limit

EPA = U.S. Environmental Protection Agency

LOD = limit of detection

LOQ = limit of quantitation

PQL = practical quantitation limit

RBC = risk-based concentration

RG = remediation goal

ROD = Record of Decision

VISL = vapor intrusion screening level

µg/L = micrograms per liter